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Exemplar Instructional Material for Pre-vocational Course under Work Experience on

PLANT PROTECTION

Instructional-cum-Practical Manual
Classes IX—X

A.K. DHOTE
Project Coordinator

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
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FOREWORD

The National Council of Educational Research and Training has developed its new framework document for the Ten-Year school titled 'National Curriculum for Primary and Secondary Education — a Framework'. This document is a forerunner of the new National Policy on Education (NPE), 1986, which incorporates the basic philosophy of the national curriculum into the policy framework. Both the 'Framework' and the Policy were developed after a great deal of national debate and deliberations through national and regional seminars and a variety of other modes of interaction and exchange of ideas. These are two historic documents which hold the promise of revolutionizing the content and process of school education throughout the country. The Programme of Action document which provides an elaboration of NPE'86 has recommended the development of curricular guidelines and exemplar curricular and instructional materials. In order to provide details in respect of various ideas in the two documents it was felt necessary to develop detailed curricular guidelines, exemplar curricular frames and instructional materials in various areas.

The Policy envisages integration of productive work with education and states that, "Work Experience, viewed as purposive and meaningful manual work, organized as an integral part of the learning process and resulting in either goods or services useful to the community, is considered an essential component at all stages of education, to be provided through well-structured and graded programmes. It would comprise activities in accord with the interests, abilities and needs of students, the level of skills and knowledge to be upgraded with the stages of education. This experience would be helpful on their entry into the workforce. Pre-vocational programmes provided at the lower secondary stage will also facilitate the choice of the vocational courses at the higher secondary stage".

In pursuance of this Policy and the Programme of Action and to maintain continuity with the curricular guidelines and syllabi developed by NCERT a set of exemplar instructional materials have been developed for use in schools. The present title "Plant Protection" is a part of this series. It has been developed by the Department of Vocationalization of Education by involving experts in the subject area, teachers and curriculum experts. I am grateful to all those who have contributed to this work both within and outside the Council.

I hope the students and teachers using this material will find it useful in performing the desired work experience activities. Further, in view of the fact that it is one in the series of exemplar instructional materials, it is also hoped that those concerned with the development of a variety of instructional materials will find it of great help in developing similar materials to suit the needs of students in widely varying situations in the country.

P.L. MALHOTRA
DIRECTOR
National Council of Educational Research and Training

New Delhi
January 1987

PREFACE

The NCERT Document, "National Curriculum for Primary and Secondary Education — a Framework" and the National Policy on Education — 1986 have accepted the concept of Work Experience to be included as an integral component of education at all stages of education, particularly the school stage. In pursuance of the conceptual framework presented in these documents the Department of Vocationalization of Education had developed guidelines for curriculum development and implementation and a set of exemplar pre-vocational courses under Work Experience. The guidelines cover all stages of school education while exemplar courses have been developed only for the upper primary and secondary stages of education. The two documents, though intelligible independently of each other, constitute two sister volumes dealing with the same subject.

The Department has gone further to develop a set of twenty exemplar instructional materials in the first instance which cover major areas of Work Experience in School Education. The present title was developed in a workshop held at NCERT, New Delhi from 8 to 12 September, 1986 in which several subject experts, teachers and curriculum specialists participated (list given elsewhere). The manuscript was further refined by Dr A.K. Dhote, the Project Coordinator concerned with this title and brought in the final form for publication. Kumari Ritu Verma was overall coordinator for the workshop in which the materials were developed and was helpful in keeping track of the work during the course of their publication. I wish to place on record my grateful appreciation for the work done by all concerned in respect of this publication.

It is expected that the students and teachers as well as the curriculum developers who use this publication may find it useful. The Department will be happy to receive their comments for further improvement of the material.

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INTRODUCTION

National Policy on Education (1986) envisages Work Experience as an essential component at all stages of education to be provided through well structured and graded programmes in accordance with the interests, activities and needs of students and the level of skills and knowledge to be upgraded with the stages of education. This experience would be helpful on students' entry into the workforce. Pre-vocational Programmes at the lower secondary stage are expected to facilitate the choice of vocational courses at the higher secondary stage and the smoother transition from school to working life.

Pre-vocational Course of *Plant Protection* under Work Experience for standards IX and X is designed essentially on the above premises as it offers a work area which is obtained practically everywhere in the environ where the students live — kitchen gardens, lawns, public gardens, school gardens/farms, agricultural fields. Even day-to-day household problems like storage of grains and other edibles, proper handling and use of common plant protection chemicals and equipment, increasing shelf life of farm produce through appropriate post-harvest treatment etc. have also been included in this pre-vocational course so as to make it really relevant to the needs, interests and abilities of the students.

The manual contains 14 exemplar activity units, many of them with several sub-units, which can be easily conducted under average school conditions. Necessary information relevant mainly to the activity to be undertaken, precedes the procedural part in each activity unit and thus, enlightens the students about fundamentals of the exercise they are going to organize. The instructions for doing each exercise are simple unambiguous and step-by-step leading the successful completion of the exercise.

The course is expected to give adequate orientation and exposure to students about the fascinating world of plants and their protection and thus, may assist them when they step into the world of work or choose to go in for further training in plant protection or allied vocational courses.

1. Activity Unit

FAMILIARIZATION WITH COMMON PLANT PROTECTION CHEMICALS AND THEIR FORMULATIONS

1.1 Relevant information

Plant Protection Chemicals

The various chemicals being used in agriculture are either plant production chemicals or plant protection chemicals. The plant production chemicals are fertilizers, plant growth regulators etc. and they help in an improved plant growth and yields. The plant protection chemicals on the other hand are used to protect the crops against damage by various pests such as insects, fungi, bacteria, weeds, namatodes etc. These are accordingly named insecticides, fungicides, bactericides, weedicides, nematicide and so on.

Currently, a large number of chemicals are finding use in plant protection. Those belong to different chemical groups and are characterised by a distinct mode of action i.e., they may act as stomach poisons after being orally ingested or consumed by the organism or these may act as contact poisons, killing the organism when they come in contact with them and so on.

The common plant protection chemicals are insecticides, fungicides, weedicides, nematicides and rodenticides.

Formulations

Most chemicals are formulated before use. A formulation may be defined as transformation of the active material in such forms which improve its application, handling, storage and effectiveness. Such materials have to meet a number of requirements prescribed by various agencies such as Indian Standard Institute (ISI), World Health Organization (WHO), Collaborative International Pesticide Analytical Council (CIPAC), Food and Agricultural Organization (FAO), Agency for International Development (AID) etc. The pesticide formulations are either solids or liquids. The examples of solid formulations are dusts (blends of toxicant with diluent) water dispensible powder (Blench of toxicant with diluent + dispersing agent), granule (blends of toxicant with diluent or diluent + binder and finally cut into granules of different sizes) and dry flowables. The common liquid formulations are solutions (toxicant dissolved in a solvent), emulsifiable

concentrate (toxicant + emulsifier dissolved in a solvent) and wet flowables.

Advantages

1. The plant protection chemicals constitute a vital input for increasing agricultural production.
2. These are effective at rather low concentrations.
3. The formulations of these chemicals provide an economic, effective and safe means of combating pests.
4. The formulations ensure an economic, effective and safer application, handling and storage of the toxic plant protection chemicals.

1.2 Precautions

1. Read instructions properly.
2. Handle the products carefully.
3. Keep the various antidotes ready.
4. Store the products in a cool and safe place.
5. Dispose of the damaged and used containers carefully.
6. Wash hands and other parts of the body immediately after handling the pesticide.

1.3 Materials required

1. Insecticides
   Chlorinated hydrocarbons:
   DDT, BHC, Aldrin Endosulphan
   Organo-phosphorus compounds: Malathion, Phorate, Monocrotophas
   Carbamates Carbaryl, Carbofuran.
   Botanicals : Pyrethrins, Neem.
   Synthetic pyrethroides: Fenvalarate, Cypermethrin
2. Fungicides
   Organo mercurials : Based on phenyl mercury acetate
   Copper based : Bordeaux mixture, Copper oxychloride
   Sulphur based : Wettable sulphur
   Heterocylic compounds: Captan
   Dithiocarbamates : Maneb, Zineb
   Organo-phosphorus : Hinosan
   Antibiotics : Tetracycline
3. Weedicides:
   Phenoxyalkane carboxylic acids: 2, 4-D
   Substituted amides : Propanil
   Ureas : Diuron
   Chloracetamides : Alachlor, Butachlor
   Triazimes : Adrazine, Simazine
4. Nematicides : D D
5. Rodenticides : Zinc phosphide, Warfarin, Gophacide
6. Formulations: Available emulsifiable concentrate, water dispensible powder, dust, granule, solution and dry and

wet flowable formulations of toxicants.

1.4 Procedure

—Observe the physical form of various toxicants and their formulations and note the salient features. Note whether it is a soild, liquid, semi-solid etc., its colour, smell, and any other prominent character.

—Dilute the various formulations employing the prescribed diluent. Observe (a) What type of emulsion an emulsifiable concentrate gives (b) What type of suspension a water dispensible powder gives (c) How a granular product looks like and what are its size and shape.

1.5 Questions

1. Name some important plant protection chemicals and give their chemical groups.
2. In what forms are the plant protection products usually formulated? Give examples.
3. Name some agencies prescribing specifications for pesticidel formulations.
4. Why are pesticides usually formulated?
5. Why should you wash your hands carefully after handling pesticides?
6. Why should an empty container of pesticides be destroyed?
7. Can we reuse empty containers of pesticides after cleaning and washing them thoroughly?
8. What can happen if we do not maintain the required concentration in a working solution of any pesticide?
9. What you will advise to use — a very concentrated solution of a pesticide or its very weak solution?
10. Is it proper to mix several types of pesticides in a single solution and use it against a variety of pests for more economy of time, labour and money?

2. Activity Unit

FAMILIARIZATION WITH INSECT - PESTS OF IMPORTANT CROPS AND THEIR CONTROL

2.1 Relevant information

How do insect-pests damage the crops?

Several types of insect-pests attack our crops. Some cause damage to leaves by chewing out the lamina parts or eating out the chlorophyll, thus affecting the photosynthetic activity, just like grasshoppers, beetles and larvae of several lepidopterous insects. Others as aphids, jassids and bugs suck the sap from growing tips or succulent plant parts, thus reducing their vitality. Some of such insects also transmit plant diseases. Some insects bore plants, shoots, fruits and roots — making them unfit for sustaining the plant stand in the field or for consumption.

Where do they live?

Some insects live their entire life on he plants while certain others pass a part of their life in soil and a part on the plants. Insects like termites pass their entire life in the soil. However, these eed on the plant residues left after harvest and at times damage the standng crops/plants too.

low is their life cycle?

Insects have three or four stages through which they complete their life cycle. The period of the cycle is variable ranging from 10-12 days in houseflies to 30-50 days in most insects which belong to lepidoptera (months and butterflies) and coleopltera (beetle) groups. There are insects like cicada which take years to complete their entire life. The life cycle may be shortened or prolonged depending upon unfavourable or uncongenial conditions of host/food plants, environmental conditions like temperature, humidity, rain, wind sunshine, and shelter places on the plants, soil, buildings etc.

The different insect stages are egg, larva, pupa, and adult as found in butterflies and beetles while the three stages like egg, nymph and adult are found in aphids, jassids and other bugs. The most vulnerable or susceptible stages of an insect pest to be tackled are larva and adult and nymph and adult in these two groups of insects. It is difficult to kill insect pests in egg or pupal stages. However, biological control methods using parasites may be used. The larva may pass through first to fifth instars (age groups depending on size), the first two instars are relatively more

susceptible than the rest. The last instar is most hardy. Males are usually more susceptible than females.

How to control insect-pests?

Insect control can be achieved through:

(1) *Agronomic practices*— i.e. cultural practices, change in date of sowing summer ploughing, flooding, use of resistant varieties etc.

(2) *Mechanical and physical methods* i.e. hand picking, shaking plant trees, light and attractant trips, heat, sunlight etc.

(3) *Biological agents* like parasites, predators and micro-organisms.

(4) *Chemicals* - like pesticides, pheromones, chaemosterilants, attractants and repellents, hormones.

(5) *Legal methods*

Insect pest control depends on their correct identification since many of the methods are specific in their action.

Description and control of some of major insect pests is given in Table 1

2.2 Precautions

— Study the insect pest carefully (with regard to its different stages, instars and total life span. Note characteristic features of the adult.)

— Preserve the insect carefully for future reference.

— Attempt correct identification, else any control practice will not give the desired effect. (Help of the established institutes like IARI, Agrl. Universities etc. may be sought for the purpose.)

2.3 Materials required

1. Important insect pests of the following crops:

a Cereals : Maize — stem borer
Paddy — stem borer, gandhi bug, hispa, gallfly
Wheat — stem borer

b. Pulses : Gram — pod borer
pea — stemfly

c. Oilseeds : Mustard — aphid, sawfly
Sesame — stem borer, gallfly

d. Cash crops: Cotton—bollworm, jassid, aphid, whitefly. Sugarcane—pyrilla, mealy bug, top shoot borer.

2. Dissection box — containing knife, scalpel, lacerator etc.
3. Brushes, pins, papers, measuring tapes, scales etc.
4. Magnifying glass
5. Microscope (binocular)
6. Glass jars, beakers, petridishes, slides and cover slips.
7. Cages — cloth, wiregauze, killing bottles.
8. Collection boxes
9. Chemicals — spirit, Canada balsom, chloroform.

10. Different insecticides (Ref. Activity Unit 1.)

2.4 Procedure

2.4.1 Maize stem borer

— Collect infested plants at about 21 to 25 days of germination.
— Dissect the plant and remove larvae.
— Observe infestation pattern, measure length and number of tunnels.
— Transfer few larvae to fresh host material i.e. uninfested maize stem and provide/replace food as and when required.
— Observe and record the completion of life cycle until adult moth is formed.
— Note the instars of larvae and days to complete the stage to form pupa.
— Note the pupal type and days to emerge as adult.
— Transfer adult moth to different jars covered all around with black paper to arrest light and provided with sugar solution in cotton web placed in a small specimen tube.
— Observe mating and note the egg laying pattern on the paper strips.
— Note days required for larval emergence.
— Transfer larvae to food—fresh maize stem cut and held together with rubber band.
— Repeat above procedure.
— Note salient points of identification of larvae and adults — like colour and colour pattern, length, size, any morphological character.
— Preserve the collected specimens in jars/collection boxes.
— Compare above salient characters with the identified specimen to be sure of your own identification attempt.
— Visit field and look for pest infestation. Note the type of injury/damage it brings in to the plant. This may sometimes serve as a guide to pest identification also.
— Assess number of the pests — through plants infested, usually one larva infests one plant.
— Select suitable control measure as per situation. (Removal of dead hearts is one of this measures).
— Apply pesticide.
— Observe effectiveness by recording mortality.

2.4.2 Mustard aphid

— Collect infested plant and note the aphid population over it. (Aphids in the initial stages attack the tender leaves. When the plant is about a month old, these

TABLE 1 · **Insect-pests, their description and control**

Insectpest	*Description*	*Control*
Maize stem borer	Dirty brown moth nocturnal in habit, lays oval eggs in clusters on underside of leaves Caterpillars feed on leaves and bore into stem and cobs; attacked plants remain stunted or die.	Remove stubbles and use light traps for adult moth, release egg parasite, *Trichogramma evanescens munutum* R. Apply endosulfan EC. Spray (0.05%) after 15 days of germination and repeat 15 days' later or 4% granules after 15 days of germination.
Paddy stem borer	Caterpillars bore into stem; central shoot withers and produces dead hearts; pest active between March-November.	Remove stubbles, Use light traps for moths, Spray endosulfan (0.05%)
Paddy gandhi bug	Straw coloured bugs emit foul smell, suck milky sap of tender grains; leave chaffy earheads resulting in complete loss of crop.	Clean cultivation, Burn trash, Shake plants to drop young nymphs in water, Dust 5% BHC at the rate of 20 kg/ha.
Paddy hispa	Small blue black beetle covered with spines, grubs make long winding tunnels in leaves, causes heavy losses in seed beds.	Clean cultivation, Dust 5% BHC at the rate of 20 kg/ha
Paddy gallfly	Maggots (larvae) attack base of growing part and produce a silvery gall (silver shoot)	Remove grasses from bunds and use light traps for adult insects.
Wheat stem borer	A pinkish brown caterpillar with cylindrical body, bores into stem and kills central shoot, moth straw coloured and lays eggs in clusters inside leaf sheath	Remove and burn stubbles, Spray endosulfan (0 05%) or gamma BHC (0.1%)
Gram pod borer	A green caterpillar with gray longitudinal streaks, feeds on tender folige and pods pupate in soil, moth yellowish brown and lays solitary eggs of greenish yellow colour	Caterpillars may be hand picked, Dust 10% BHC or 4% endosulfan at the rate of 20kg/ha.
Mustard aphid	A greenish white aphid, affected leaves get curled and plants inflorescence whither and die.	Spray 0 05% malathion or 0 02% dimecron (phosphamidon) or 0.04% monocrotophos
Mustard sawfly	A blackish caterpillar that attacks all crucifers, feeds on leaves of young seedlings, curls and falls on the ground when touched. Adult is a black fly that lays eggs singly inside the leaf tissues	Remove larva by hand-picking if infestation is light. Dust 5% malathion or 2% methyl parathion at the rate of 20 kg/ha
Sesame stem borer	A small brown moth whose pale green caterpillars feed on leaves and bore into shoot and fruits, caterpillar makes a web into top leaves by folding them and pupates in greenish white cocoon.	Affected shoots and leaves may be hand picked. Dust 4% endosulfan at the rate of 20 kg/ha.
Sesame gally fly	A mosquito like fly whose maggots feed on flower buds producing a gall, buds fade and fall	Remove and destroy shed buds.
Cotton bollworm	A pink or deep pink caterpillar that bores into bolls and seeds and pupates therein, adult is a small blackish brown moth.	Treat seeds before sowing by sun-heat treatment. Remove and destroy fallen buds and bolls. Spray monocrotophos 0.4% or permethrin 100 g/ha.
Cotton jassid	A small greenish leaf hopper whose nymphs and adults feed on leaves which turn yellow, plants remain stunted.	Spray 0.02% phosphamidon or 0.04% monocrotophos.
Cotton whiteflies	Very small flies that feed (suck) on leaves on the under surface, affected leaves curl and dry up and plants remain stunted, also act as vector of virus diseases	Late sowing and frequent irrigation lead to less attack Spray insecticide (as for cotton jassids).
Sugarcane top	Adult moth creamy white in colour with luft of	Remove infected parts of the plants and destroy.

shoot borer	hairs at the abdomen, larvae bore cane from the top and damage growing portion	clean cultivation. Apply endosulfan 0.05%
Sugarcane pyrilla	Straw coloured. about a cm leng adults, with conspicuous long head, nymphs resemble adults but with long paired waxy analfilaments, both suck sap and devitalise plant growth, sugar content reduced.	Clean cultivation remove stubbles. Apply phosphamiden 0.02%.

migrate to growing tips).

— Note aphid occurrence on the growing tips and young tender shoots. This is usually at 45 days of sowing.

— Observe the multiplication which is very rapid through parthenogenesis (adults giving birth directly to young ones instead of eggs).

— Note the number of aphids in a unit area.

a) In initial stages, the whole leaf may be taken as a unit, while in the latter stages, the top, middle and lower leaves would form the unit.

b) At the inflorescence stage, one or two twigs per plant, upto a length of 10 cm may form a unit.

— Observe the symptoms of injury on leaves, young shoots and inflorescence. Both nymphs and adults suck plant sap and bring about reduction in the vitality of plants and cause injury spots on the leaves.

— Observe for honey dew secretions and the development of shooty moulds on the leaves etc.

— Record the period through which aphids pass their life and attain the winged stage. This is usually associated with rise in temperature and takes place in late February to March.

— Select suitable insecticide and apply when the pest population attains high levels, usually in the last week of December and January. Repeat after 15 to 25 days.

— Observe effectiveness by recording mortality after application.

2.5 Questions

1. What are the different stages through which the insects pass?
2. What is an instar? How many instars occur in a lepidopterous larva?
3. In what ways insects cause damage to crop plants?
4. Which insects live in soil?
5. How does maize stem borer cause damage?
6. Why a correct identification of an insect is essential ?
7. What are the different control methods to central insect pests?

3. Activity Unit

IDENTIFICATION OF DISEASES OF IMPORTANT CROPS

3.1 Relevant information

Why is it necessary to identify a plant disease?

Plant diseases come from seed on soil and spread quickly through air, water, insects and other agencies. Unlike man or animal there is usually no cure of a plant disease. One can only protect a healthy plant from becoming diseased or a healthy leaf of a plant from getting disease from the neighbouring leaf.

What parts of plants are affected by disease?

All parts including fruits, flowers, buds, leaves, twigs, stems, collar foot and root are affected by plant disease.

How to identify a disease?

A plant disease is noticed with an abnormality in form, function and growth of a plant. Any abnormality is expressed in the form of different signs of dis ease called symptoms. These symptoms are typical of a plant disease. The chief diseases and their symptoms are:

(i) **Mildew** : Disease in which the fungus is seen as a growth on the surface of the host. They appear as white, grey, brownish or purplish patches of varying size on leaves, herbacious stems, fruits. In *downy mildew* the superficial growth is cotton thread-like spreading on the lower surface of leaves, stems, and other parts. In powdery mildew millions of spore are formed on superficial growth of fungus giving a look as if white powder is spread, particularly on upper surface of leaf, stem or fruits.

(ii) **Rust** : The fungus grows inside host body and emerges out from different points in leaf, stem or fruit in the form of pustules of iron rust colour.

(iii) **Smuts** : The grains or other floral parts particularly cobs, ears or spikelets are converted in the form of sooty charcoal-like powder.

(iv) **Leaf-spots** : Dead areas of different colour appear on any part of leaf, particularly leaf lamina. The spots may be of pin size to big patches.

(v) **Rots** : Tissues of leaf, stem, fruits

or roots rot making big patches of dark colour.

(vi) **Discolouration** : It may be due to parasitic or non-parasitic diseases. The colour of the foliage or whole plant or some part may fade or change to yellowing, browning etc.

(vii) **Canker :** In cortical tissues of stem, fruits or leaves corky growth develops due to diseases. These symptoms are common in perennial plants like fruit trees.

(viii) **Anthrocknose :** Circular, angular or irregular spots or dead areas along the leaf vein, petioles, stem, or fruit develop due to diseases. Affected tissues are discoloured.

(ix) **Blight and blast :** The tissues of affected parts, particularly the leaves are killed rapidly by the disease. The parts so affected are foliage, blossom. When the entire leaf blade and buds die quickly, then it is known as blast.

(x) **Dieback :** Twigs or branches of the plant die starting from their tip and advancing backward. It is called dieback.

(xi) **Damping off :** In seedlings or young plants the basal portion rots rapidly with the result the plants fall down. This disease is usually so devastating that all the plants of the nursery or a patch of it are toppled.

(xii) **Wilting :** When vascular bundles of the plant are affected the plants shows flaccid or drooping condition. It may result gradually or suddenly with or without yellowing of the leaves.

(xiii) **Outgrowth :** Sometimes the plant parts enlarge or produce outgrowths like galls, tumer nodes etc. due to organisms growing inside the body of plants.

(xiv) **Miscellaneous symptoms :** Due to disease organism growing inside the body of plant sometimes we can notice some symptoms like gummy substance called exudates, colour variation called mosaic, puckering and curling of plant leaves. Sometimes the plants remain small (dwarf) due to shortening of internodes or the floral parts develop into leaf-like structure green in colour called phyllody. In yellows the affected plants become pale yellow in colour and produce virescence.

Disease diagnosis

This includes the steps which are necessary to prove that a plant is not normal and it is suffering due to some foreign cause. These steps are:

(i) **Check up** — including activities to find out the difference between healthy and affected plant of the

same field.

(ii) Clinical diagnosis — which involves examination to find out whether some organism or any agency is responsible for the suffering of the plant.

Thus steps are carried out in various sequences as exemplified in the following table:

S. No	*Name of disease and casual organisation*	*Identifying symptoms*	*Extent of damage*	*Control*
1	2	3	4	5
	CEREALS			
1.	Rust of Weat *Puccinia graminis tritici* *P. recondita* *P. striformis*	Reddish brown, brown or bright yellow specks (pustule) develop on stem, sheath, or leaf They give rusty appearance to the surface and sometimes burst to release powder just like iron rust powder	Whole foliage is affected resulting in heavy yield loss.	- Grow resistant varieties - Spray dithio carbamates or Zineb-zinc sulphate combination at the rate of 0.25% 4-5 times
2.	Bacterial blight of paddy *Xanthomonas Ozyzae*	- Dull greenish water soaked or yellow spots 5 to 10 mm in size extending length-wise of leaf and increasing toward tip This leads to tip or marginal drying. Bacteria ooze out in water when leaf is cut into pieces.	Grain formation in ears reduced	- As the disease is seed borne, the seeds should be soaked for 8 hours in Agrimycin (0 025%) and wettable ceresan (0 05%) - Hot water treatment of seed at 52-54° C for 30 min. - Soak seed in strepto-cycline (3 g in 11 litre in 8 hours) Spray copper oxychloride at the rate of 0.25% for 2-3 times
3.	Smut of Jowar *Sphacelotheca sorghi* *S. cruenta* *S reliana*	- Disease appears on cobs and ears. Smut powder black in colour is formed in place of grains All or a few grains are converted into smut powder	About 25% grain yield is reduced in some cases.	- The disease is externally seed borne. Treat seed with Thiram 2-4 g/kg. Seed before sowing. - Use resistant varieties
4.	Karnal bunt of wheat *Neovossia indica*	- Few or all the grains of the ear are replaced by balls/galls which are round hard structures When the glumes are pushed apart in the ear it is the initial sign of disease	Yield is reduced due to loss of grains.	- Grow resistant variety - Clean away bunted grains from the seeds. Follow field sanitation and crop rotation.
	VEGETABLE CROPS Late blight of potato			
5.	*Phytopthora infestans*	- Water soaked, light brown lesions on the leaf blade. If weather is cloudy and moist dirty brown large lesions spread on leaf, and stem, cause death of foliage. Field appears as if the crop is burnt in fire. Tubers may rot or form green hard portions.	All above ground parts, tubers are affected resulting in yield loss.	- Obtain seed from certified agencies. - Treat seed tubers by dipping in 0.25% Copper fungicides. - Spray copper fungieside or Zineb at 15 day interval. - Use resistant varieties - Adjust sowing dates.

6.	Root Knot of Brijal *Meloidogine javanica* (Nematodes)	- Small or big knots are formed in roots and rootlets. - Plants remain dwarf and stunted, bear less or no fruits	Nematodes have very wide host range and affect many vegetable crops. - Affected plants bear less fruits.	- Do not grow host crop in the field for 2-3 years. - Plough field 2-3 times in summer months.
7.	Wilt of Gram *Fusarium orthoceros*	- The fungus is present inside the Vascular bundles of plants Due to blocking of water supply yellowing of lower leaves takes place. - Drooping of top leaves followed by drying of foliage.	- So many plants die and thus per unit yield is reduced	- Fungus lives in soil. So follow summer ploughing and crop rotation. - Use resistant varieties.
8.	Yellow mosaic of Mung (Green gram) caused by virus which is spread by insect *Bemicia tabaci (white fly)*	- Green and yellow patches develops on leaves - On young leaves yellowing of leaves is more pronounced - Flower drop and fruit deformation take place.	Yield losses are high upto 7-10%	- Use resistant varieties - Spray insecticide (Rogor at the rate of 0 05%) for 3-4 times for control of insect vector.
9.	Damping off of tomato *Phythuum debarya num*	- Seedling as young as 2-3 days suffer during rainy season. - Basal portion of seedlings rot and plants fall down forming paches of dead seedlings in the nursery.	Sometimes reso-wing is needed as the entire seedlings die. - Sowing is delayed.	- Prepare nursery bed by ploughing 4-5 times in summer months. - Follow crop rotation in nursery bed. - Treat seeds with captan at the rate of 3 g/kg. - Drench nursery bed with 0.2% suspension of captan.
10.	Bacterial wilt of chillies. *Pseudomonas solanacearum*	- Plant wilt suddenly at the time of fruiting without yellowing.	- 5-10 yield loss	- Plough field during summer 4-5 times at 20 to 30 cm depth. - Grows seedling in disease free soil.
	OIL-SEEDS			
11.	Bud rot of coconut *Phytopthora palmivora*	- Discolouration of the heart leaf which becomes yellowish green. Basal portion of leaf rot quickly. - Due to bud rot the plant lose the crown and growth from the top stops.	Plant does not bear fruit in some cases	- Spray plants with 1% Bordeaux mixture or 0.25% copper fungicide.
12.	Sesamum phyllochy caused by Myco-plasma which is spread by leaf hopper	- Most of the flowers change into leafy structures. The inflorescence changes into a bunch.	- 70% flowers are damaged.	- Follow crop rotation. - Spray systemic insecticide like Rogor for 3-4 times.

	Orosins albicintus FRUITS			
13	Mango malformation - physiological disorder - eriophyidmites - virus - *Fusrium Moniliformus.* It makes a complex	- In vegetative malformation the young leaves of growing twig are converted into leafy structures - Floral parts of inflorescence are converted into leafy structure forming a big bunch.	- No fruit is formed in the affected inflorescence.	- Use resistant varieties. - Remove affected parts immediately.
14.	Black tip of Mango Exposure of plants to certain gases, like ethylene, emanating from brick kilns	- Black patch appears on fruit skin	- Fruit quality is destroyed.	- Do not put brick kilns near the mango orchard
	SPICES			
15.	Stem gall of coriander *protomycu macrosporums*	- Enlarged growths in the form of galls are formed on flower parts, leaf, stem, and petioles	- Loss of foliage and seeds	- Clean the seed free of galls. - Summer ploughing. - Spray Dithane 0 25% 3-4 time.
15.	*Plantation crops* *Coffee Rust* *Hemileia Vastutrix*	- Fruit pustules occur on berries which are yellowish in colour Leaves drop down soon when pustules appear on them	- All plant parts affected causing big-loss to foliage	- Spray Bordeaux mixture (0 5%) 3-4 times. - Use resistant variety
16.	Blister blight of Tea *Exobasidium vexans*	- Small, pale or pink, round spots on young leaves These spots enlarge in size soon upto 2 cm. and protrude out enough to give blister like show.	- Loss of foliage.	- Spray copper fungicide 0.25% to 4% at regular intervals.
17.	Kattle disease of cardamum It is caused by *virus* which is spread by insects	Discolouration of youngest leaves with pale green stripes from mid rib towards periphery. - Leaves reduced in size, - Dwarf and stunted plant	- Plant becomes useless within 2-3 years.	- Virus is carried through rhizome - Diseased rhizomes should not be used. - Spray insecticides for the control of insects - Roguing of diseased plant

3.2 Precautions

— Do not wait for disease to spread in the field.

— Be quick in observing the diseases in field and control them at very initial stages.

— Plant disease has no cure. Protect the plant by preventing entry of disease in the field.

— Follow recommended practices of plant disease control.

— Do not forget to use certified seed and treat it before sowing.

3.3 Materials Required

Potato seed tuber— 4 kg.
Any copper fungicide— 5 g.
Dithane Z 78 fungicide— 5 g.

Plastic bucket with water.
Knife and plastic trough.
Measure for water.
Knapsack sprayer.

3.4 Procedure

— Prepare fungicide suspension in plastic trough.
— Dip potato tubers in this suspension.
— Cut the tubers with knife.
— Again dip cut tuber in fungicide suspension.
— Use these tubers for sowing.
— Visit the field periodically.
— Bring the leaves of potato if they show signs of disease. Compare these signs with those given in the table.

If the given disease happens to be late blight of potato then spray as prescribed below:

— Prepare fungicide suspension in plastic bucket.
— Fill the suspension in sprayer.
— Spray fungicide on crop in field.

3.5 Observations

— Observe the crop of potato in plots sown with treated and untreated potato tubers.
— Observe whether the disease appears first in crop from treated or untreated seeds.
— Observe the number of healthy and diseased plants in plots which were sprayed with fungicide and which were not.
— Observe the yield of plots in which disease control practice was done and in which it was not done.

3.6 Questions

1. What is a plant disease?
2. How plants show that they are suffering from a disease?
3. What parts of plant are affected by diseases?
4. How you shall judge that the disease has come in your field?
5. What you will do if you notice a disease in the crops of your field?
6. How you shall spray the crop for disease control?
7. Why is it necessary to control a disease?

4. Activity Unit

IDENTIFICATION OF PEST DAMAGE

4.1 Relevant information

It is observed that generally it is a problem for many of the farmers to identify the cause of a damage to crop. They are unable to attribute it to the real casual organism i.e. whether it is caused by a disease or insect.

Types of damage

Four types of damages may be observed in the field. (a) There are insect damages, (b) disease damage, (c) physiological deficiencies, and (d) mechanical damage.

When a crop is damaged by insects it is observed that parts of a leaf in an irregular portion are missing. In reverse cases only the mid rib and veins remain. In some cases the vein skeleton is observed but no green (chlorophyll) matter is seen. Excreta in the form of small green balls can be observed on the plant parts. If the insect causes damage during day time, then either the adults or larvae of the insect can be observed eating away parts of the plant.

If a disease attacks a crop the plant may wilt and die. Parts of leaves show water soaked lesions and rot in patches. The petiole and stem become soft, rot and turn black. If the stem is cut open we can observe that the inner tissues have turned black and pith of the stem completely destroyed.

In some other diseases, part of the leaves rot and become gummy. The leaves may also lose their dark green colour and show mosaic pattern of dark and light green colour. In other cases the leaves curl up or are thickened or mottled or have brown spots with dead tissue inside. However, in any of these cases we do not observe the missing of parts of the plant.

When nematodes attack a crop the plants show stunted growth. In severe cases, the leaves may dry up and tear off in between the veins. When the plant is uprooted, it can be observed that the roots show large galls and thickening of the tender root system.

In the case of physiological defeciency, the morphology (external appearance) of the plant may change. Leaves may show chlorosis. At times malformation of leaves can be observed. The leaves also may show white specks/spots or dark green thickened patches with irregular and serrated leaf shape. In rare cases stunted growth and extremely high number of leaves can be observed. However the plant does not die.

At times the damage can be mechanical

The common damage observed in earlier stages of a crop, when it is tender is spotting which is caused mainly by hand spraying operation very close to the plant. The powerful jet of the spray pierces the tender tissues and kills the cells resulting in a spot. This should not be mistaken for a disease since the new leaves and leaves that are not damaged will not show this spotting. Another type of damage that is observed is "sun scalding" in insufficient water supply conditions, especially when the plant is growing luxuriously. The leaves get scorched and dark green, soft, wilting spots are observed on the leaves and the leaf droops downwards. The other type is partly tearing off of leaves or crushing and bruising of leaves observed at the end of the rows and leaves of spreading branches within the row. This is caused during inter cultivation with bullocks by their crushing the plants and leaves.

Advantages of identification of damage

1. Correct identification helps in selecting proper and timely control measures.
2. Heavy losses can be prevented.

4.2 Precaution

4.2.1 *Insect Damage*

— Collect samples of typical damage and not the odd types.

— Observe for excreta on other leaves and branches.

— Collect if there are any live insects present on the crop.

4.2.2 *Disease Damage*

— While collecting samples, take care to see that entire plant is uprooted and taken.

— Do not touch healthy plants with disease contaminated hands. Wash your hands thoroughly.

— Bury the samples of the observation in a pit.

4.2.3 *Physiological Deficiency*

— Observe whether there is any morphological change in the character of the plant.

— Observe whether this phenomenon is spreading to other fields plants.

4.2.4 *Mechanical Damages*

— Observe the plants at the end of row.

— Enquire whether inter cultivations/sprayings are carried out in the recent past.

4.3 Materials Required

(i) Damaged samples.

(ii) Information regarding cultivation practices

4.4 Procedure

— Take the sample and observe whether any part of the leaf is cut mechanically.

— Search for insects eating the plant parts.

— Examine carefully whether the damage caused is mechanical or

caused by an insect.

- Examine the plant leaves and roots for blackeing, spotting or rotting.
- Observe whether there are any water lesion spots on the leaves.
- Find out whether this phenomenon is spreading to other plants/ fields.
- Observe the sample for irregular growth or more number of leaves at the nodes.
- Note whether there are any white specks on the leaves which are not spreading.
- Go through the entire plot and find out whether the damage is on few plants or in entire plot and whether it is spreading to other plots.
- Walk from one end of the crop row to the other end. Observe the type of damage to end plots and note whether it is on the end plants or all over the row/plot.
- Note the weather conditions— especially the maximum temperatures and the moisture availability (Previous rainfall/previous irrigation).
- After analysing the above factors decide whether the damage is caused by insects/diseases physiological deficiency or mechanical.

4.5 Questions

1. How does the symptoms of damage by insects differ from those of the disease damage?
2. How will you differentiate a mechanical damage from insect damage?
3. Which type of damage can be contagious?
4. How do you identify a physiological damage?
5. In what different ways can plants be damaged?

5. Activity Unit

SOIL TREATMENT

5.1 Relevant information

Why soil treatment?

Soil is the most important medium of plant growth. Hence, it is of vital importance to see that it is maintained free from insects and disease causing pathogens to get higher yields and quality produce. This is achieved by using various methods—both chemical and mechanical.

Methods of soil treatment

(a) Solar

Coming to simple mechanical methods, the abundantly available solar energy can be utilised to de-energise a number of pests. The ultra violet rays of the sun and heat of sunlight act fatally on many soil pests. Deep summer ploughing results in controlling to a considerable extent the perennial pests like nematodes and expose the eggs, grubs larvae, pupae of a number of soil insects to light and various insect enemies. It also helps to reduce the soil borne fungal pathogens.

(b) Rabbing

The same effect can be achieved by artificially giving a heat treatment to the soil. This method is called 'RABBING' and for this purpose any agricultural waste material is spread on the wet soil surface and is burned to get a uniform heat and steam supply to the soil surface, such that all the pests in the upper layers are destroyed.

In the chemical methods, different forms of chemicals (like granule, dust, solution, etc.) are used to achieve the objective of keeping the soil free from pests. The methods generally used are: mixing, drenching, spraying and fumigation.

(c) Mixing

In mixing, the chemical in the form of a powder or granules is mixed thoroughly in the upper layers of the soil surface at recommended dosages.

(d) Drenching

In drenching, the recommended chemical is made in to a solution and is applied on the surface of the soil preferably with a rose can such that the chemical spreads uniformly on the entire surface and travels down in the upper layers of the soil such that the pests in these layers are acted upon and controlled.

(e) Spraying

Spraying is slightly different in that the chemical is made into a solution and is sprayed uniformly on the entire

surface of the soil with a sprayer and later this sprayed soil is incorporated into the deeper layers and watered on the surface such that the chemical in the inner layers is released in the presence of water and acts on the pests.

(f) Fumigation

One of the modern methods to control the soil pests is fumigation of the soil with soil fumigants like methyl bromide and ethylene dibromide. The area to be fumigated is treated (injected) with the fumigant and sealed with an airtight polythene sheet for a specified time. In the process the soil borne pests are subjected to toxic fumes of the fumigant and exterminated.

5.2 Precautions

I. *Mechanical methods*

a. Use of solar energy

— Take care to see that the soil is ploughed before summer.

— Soil should be ploughed deep enough (at least 30 cm. deep).

b. Heat treatment — Rabbing

— Mark properly the land that has to be rabbed.

— Plough it well to keep the soil loose.

— Select and stockpile the agricultural waste material that would be used taking into account its availability and cost factors. (viz. paddy husk, ground nut shells, saw dust, bamboo dust etc.)

— Always burn the waste material in the opposite direction of the wind so that it burns slowly.

— Wet the soil surface before spreading the waste material to get good steam from the generated heat.

— After the rabbing is over, do not disturb the top surface too much since it may bring the unsterilised soil from deeper layers.

II. *Chemical Methods*

a. Mixing of chemicals

— Do not handle the chemical with bare hands. Always use gloves.

— Destroy the container on emptying it.

— Wear a gas mask when handling toxic fumes.

b. Drenching of chemicals

— Maintain the correct concentration.

— Prepare the solution just before application.

— Use hand gloves while drenching.

— Wash your hands and body parts thoroughly after drenching.

— If sowing of seed has to be taken up, drench the bed sufficiently early so that the chemical will not have any deleterious effect on the germinating seed.

— Carry out the operation before 9.00 A.M. or after 4.00 P.M.

— Do not take up drenching when it is raining.

— Cover the entire area without leav-

ing any uncovered patches.

c. Spraying

— Extreme care should be taken to cover the entire area as the chemical is distributed as a thin spray.
— Incorporate well inside the soil without leaving anything on the surface.
— Wash your hands thoroughly

d. Fumigation

— Fumigation should be done only by authorised (licensed) agents.
— Use gas mask while using a fumigant.
— Cover the treated area carefully without any leaks.
— Use correct tent material (that retains highest fumigant gas) for fumigation purposes failing which the fumigation will not be successful.
— Correctly follow the dwell time recommended for each fumigant.

5.3 Materials Required

Sun Exposure

— Deep ploughing equipment (disc plough or mould board plough) Tractor/Bullocks

Heat Treatment/Rabbing

— Agricultural waste material
— Water
— Match box
— Bucket and tumbler

Mixing

— Chemical
— Measures and weights
— Tyned raker
— Gloves
— Tray

Drenching

— Chemical
— Measures and weights
— Water
— Pot/container
— Rose can
— Stick or stirrers

Spraying

— Chemical
— Sprayer
— Measures and weights
— Water
— Container
— Wooden raker

Fumigation

— Chemical
— Injecting gun
— Measuring cylinder
— Sound polythene sheet without holes
— Clock
— Gas mask, gloves, goggles
— Gum/celophane tape

5.4 Procedure

5.4.1 *Exposure to sun*

— Mark the land to be exposed to sun.
— Plough the land with a tractor/ mould board plough well before summer.
— Plough the lan sufficiently deep.
— Do not allow weeds to grow since

they may provide shade to the soil.

5.4.2 *Heat treatment/rabbing*

— Earmark the land to be treated with heat.
— Loosen the soil well.
— Wet the surface with water to a depth of 2 cm.
— Spread the agricultural waste material (paddy husk or ground nut shells) on the wet surface to a height of 10 cm.
— Burn the wastes in the opposite direction of the wind such that the waste burns very slowly and steam is produced with the heat generated.
— Allow it to completely burn.
— After the burning, mix the ash in the upper layers of the soil. *Take care to see that not more than 10 cm. top soil is stirred.* Deep stirring results in unsterilised soil coming to the top layers making the operation a wasteful exercise.

5.4.3 *Mixing*

— Wear gloves and gas mask
— Take measured quantity (of recommended dosage) of the pesticide into a container
— Spread the chemical uniformly on the entire surface to be treated. (In case the quantity of chemical is very small, mix sufficient quantity of inert material for easy application).
— Stir the surface soil with a tyned raker to incorporate the chemical in the soil.
— Once the operation is over, destroy the pesticide container and wash hands thoroughly.

5.4.4 *Drenching*

— Prepare the pesticide solution of required concentration as recommended.
— Calculate per unit area the quantity of solution required and pour it in to a rose can.
— Spread the solution uniformly on the entire surface of the area to be treated by pouring it from the rose can.
— Wash the containers and hands thoroughly

5.4.5 *Spraying*

— Prepare the spray solution as per the recommendations.
— Pour the solution into a hand sprayer.
— Spray it on the unit area earmarked for treatment.
— Incorporate the sprayed soil into the top soil surface (10 cm deep) by a wooden raker.
— Depending on the recommendations water the area at regular intervals as per schedule, it necessay.

5.4.6 *Fumigation*

— Measure the chemical for noting the dosage.
— Wear gloves, gas mask and goggles.

— Inject the chemical into the soil (observe depth).
— Cover the treated area with a polythene sheet (observe the gauge of the sheet)
— Seal the treated area (observe whether there are any leaks).
— Record the dwell time (exposure time).
— Note the removal of polythene sheet.
— Assess the efficacy of fumigation by observing the post development of pests in the treated area (insects, diseases, nematodes and weeds)
— Also record whether fumigation has any detrimental effect on germination of seed or crop growth

5.5 Questions

1. How sunlight acts in de-activating the pests?
2. Why the soil should be wetted before burning for rabbing the soil?
3. What is drenching?
4. Can you take up fumigation?
5. What are the important points to be remembered while fumigating?

6. Activity Unit

PRESOWING SEED TREATMENT

6.1 Relevant information

Seed may be damaged in various ways. Many diseases and insects can harm it. The disease may be carried through seed to the next crop where it may multiply alongwith the plant. Some diseases may rot the seed during storage or reduce its germination count considerably. By seed treatment, these pathogens are killed or the seed may not allow any disease pathogens that can develop well on it.

Seed treatment may involve:

a. Dry seed treatment;
b. Wet seed treatment;
c. Seedling treatment;
d. Tuber treatment and;
e. Set or cutting treatment.

Seeds carry pathogens both in dormant and active phase. These carry diseases in the form of:

(i) Mycelia or spores of pathogens sticking to the seed coat externally.
(ii) Mycelia or spores present internally in the embryo or other internal parts.
(iii) In cuttings or sets the disease pathogen remains in active phase on the surface or embedded in the tissues or grows in the dormant bud of the planting material or inside the root tissues (of seedling) meant for supplying food material to the plant.

Seed is treated by:

a. Applying chemicals like fungicides, antibiotics or any biocide.
b. Application of heat through sun rays, infrared rays, steam or hot water.
c. Dipping the material in the suspension/solution of the biocide.
d. Improving seed health and sanitation.
e. Mechanical seed teatment such as removing plant debris, damaged or diseased seeds, galls etc.

Chemicals used for seed treatment

a. *Surface eradicants*—fungicides like thiram, dithane M-45, captan, difolatan, agallol and Agrosan etc.
b. *Systemic protectants:* compounds like carbendazim, plantvax, vitavax streptocycline, streptomycin etc.
c. *Local killers:* Elements like copper or sulphur, borax and insecticides.

Presowing treatment of seeds is a necessity. This includes treatment

of seed:

a. Just after the harvest of crop.
b. During storage
c. At the time of sowing or before sowing.

Treatment of wheat seed

Diseases inherently present in seed:

a. Internally seed borne — Loose smut of wheat.
b. Externally seed borne — Flag smut, Tundu/ear cockle, bunt, Peaf spot and black point.

Fungicides used

(i) Thiram captan, at the rate of 0.25% W/W for externally seed borne diseases.
ii) Vitavax for internally seed borne diseases.

'reatment of potato seed

Diseases for which seed treatment is carried at—
Early and late blight, virus diseases brown rot etc.

ıngicides used

Dithane M 45 (0.25%)
Streptomycin (0.05%)

:atment of Sugarcane set

Diseases for which seed treatment is done—
Smut, red rot, bacterial stripe, set rot, grassy shoot and ratton stunting diseases.

thods of seed treatment

Fungicides—Agallol 0.05%
Carbendazim 0.05%
Dithane M 45 0.25%
Streptomycin 0.05%

Hot water treatment : It is carried out in aluminium trough at 51° C.

Hot air treatment: It is carried out in a sterilizer or autoclave under steam at 54° C.

6.2 Precautions

— Do not use formulations whose activity life is over for treating the seed.
— Do not keep the treated seed for more than 2-5 hours.
— Follow the recommended dosage and regulations.
— Prepare fresh suspension from fresh chemicals (checking the expiry date).

6.3 Materials required

(i) Wheat, seeds, potato tubers and sugarcane
(ii) Water
(iii) Seed treating drum or bag.
(iv) Aluminium trough of 20 litres capacity
(v) Prescribed chemicals
(vi) Filter stirrer and a glass rod.
(vii) Source for heating or electrically operative autoclave
(viii) Piece of cloth, plastic sheet etc.

6.4 Procedure

6.4.1 a) With Chemicals

— Weigh seed of wheat and fungicide (at the rate of 2.5 g. per kilogram of seed)

separately.
- Fill the seed in seed treating drum.
- Mix the fungicide with seed and close the lid of the machine tightly.
- Rotate the drum for 2 minutes, take out the treated seed in polyethylene bags and sow immediately.
- Clean the equipment after use with dry cloth.

b) **Hot water treatment of wheat seed for control of loose smut**
- Soak seed in water for four hours. Then dip the seed in hot water having temperature of 50-53°C for 10 minutes.
- Use the seed for sowing or spread the soaked seed in thin layers on cemented floor under hot sun on a summer day of May for a period of 4 hours.
- Collect the seed and store it for sowing.

6.4.2 Treatment of potato seed
- Dip 2 kg whole potato tubers in lots which can be submerged in the suspension completely.
- Take out the dipped tubers and keep them on a cloth over a cemented floor or polythene sheet.
- Cut potato tubers in to pieces bearing one bud each.
- Again dip them in the suspension of the chemical and take out immediately.
- Allow to dry in shade and sow.

6.4.3 Treatment of sugar cane sets
a) **With chemicals**
- Take 5 grams of Dithane M 45. Dissolve it in two litres of water in a plastic trough of suitable size.
- Dip the sets in suspension and take out immediately.
- Spread parathion dust (insecticide) over the cut ends.
- Sow the sets and irrigate immediately.

b) **With hot water**
- Heat water in a big aluminium trough to 52°C.
- Stop heating when the temperature is achieved.
- Dip the sets in this hot water for one hour.
- Remove the sets after 1 hour from water and use them for planting.

c) **With hot air**
- Keep the sets on the stand in an autoclave having water in the bottom to a level of 10 cm.
- Close the lid of the autoclave
- Operate the autoclave to achieve the temperature of 54°C.
- Run autoclave at 54°C for 8 hours
- Remove the sets and sow them in field.

6.5 Observations
The pupil should record the following observations as given in

the table below:

S.No.	Characters to be observed	*Treated*	*Untreated*
1.	—Seed/tuber/set —Surface —Colour —Seed coat —Sprouting/germination —Calculate germination percentage —Disease symptoms on seedlings.		

6.6 Questions

1. Why is seed treatment necessary?
2. What is meant by seed treatment?
3. What are the stages when the seed can be treated before sowing?
4. What will happen if seeds from diseased plants or insect infested plant are stored and used for sowing?
5. What are the different types of methods of seed treatment for different types of seed borne diseases?
6. What type of diseases require heat treatment of seeds?
7. Should the healthy seed be treated before sowing?

7. Activity Unit

HANDLING AND MAINTENANCE OF PLANT PROTECTION EQUIPMENT

7.1 Relevant information

Plant protection equipment

These are machines designed to dispense plant protection chemicals over a given area to effectively control the pests.

Pests

These are organisms which cause damage to crop-plants and their produce. These may be insects, mites, fungi, bacteria, viruses, nematodes, weeds, rodents etc.

Plant protection chemicals

Commonly called "pesticides" These are used to control the pests of plants. These may be further classified into insecticides, fungicides, weedicides, nematicides, rodenticides and the like, depending upon their ability to kill insects, fungi, weeds, nematodes, rodents etc. respectively.

Types of plant protection equipment

The plant protection equipment are of several types. Those which dispense liquids in the form of jet, spray or mist are called sprayers, whilst those dispensing powders, are called dusters.

Besides, there are special equipment like, granule applicators, soil injectors, flame guns etc which find use under specific pest control situations.

Sprays are usually preferred over dusts because of the following advantages:

(i) Ease of application
(ii) Better performance
(iii) Lesser drift problem
(iv) Comparatively less active ingredients are required
(v) Under situations where water is readily available
(vi) It is comparatively safe for the workers.

Dusting is preferred under the following situations:

(i) Where water is not readily available,
(ii) For soil application,
(iii) Against chewing insect pests

Sprayers

These consist of a reservoir, an air pump, spray pipe, delivery hoses and nozzles of different types and openings.

Types of sprayers

Various types of sprayers are available for use. These are:

(i) Simple hand sprayer.

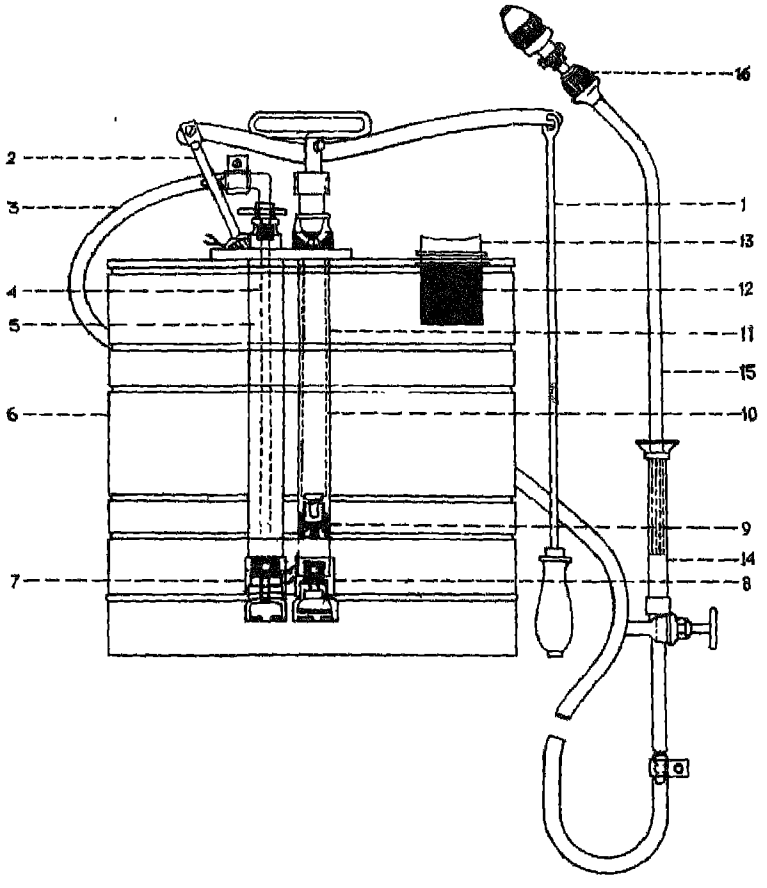


Fig 1 Manually operated hydraulic energy knapsack sprayer (with hydraulic pump) with a built-in double-barrel pump.

1—pump lever, 2—connecting rod, 3—delivery hose, 4—delivery tube, 5—pressure chamber, 6—tank, 7—delivery-assembly valve, 8—suction-vlave assembly, 9—bucket, 10—pump barrel, 11—plunger rod, 12—strainer, 13—filler hole cap, 14—wheel cut-off valve with strainer, 15—spray lance, 16—nozzle

) Stir up pumps.
) Knapsack sprayers
) Pressure sprayers (foot sprayer).
) Rocking sprayers.
) Power sprayers.

The three important types commonly used are described below.

1. *Knapsack sprayer* (Fig. 1)

A knapsack sprayer usually has a flat

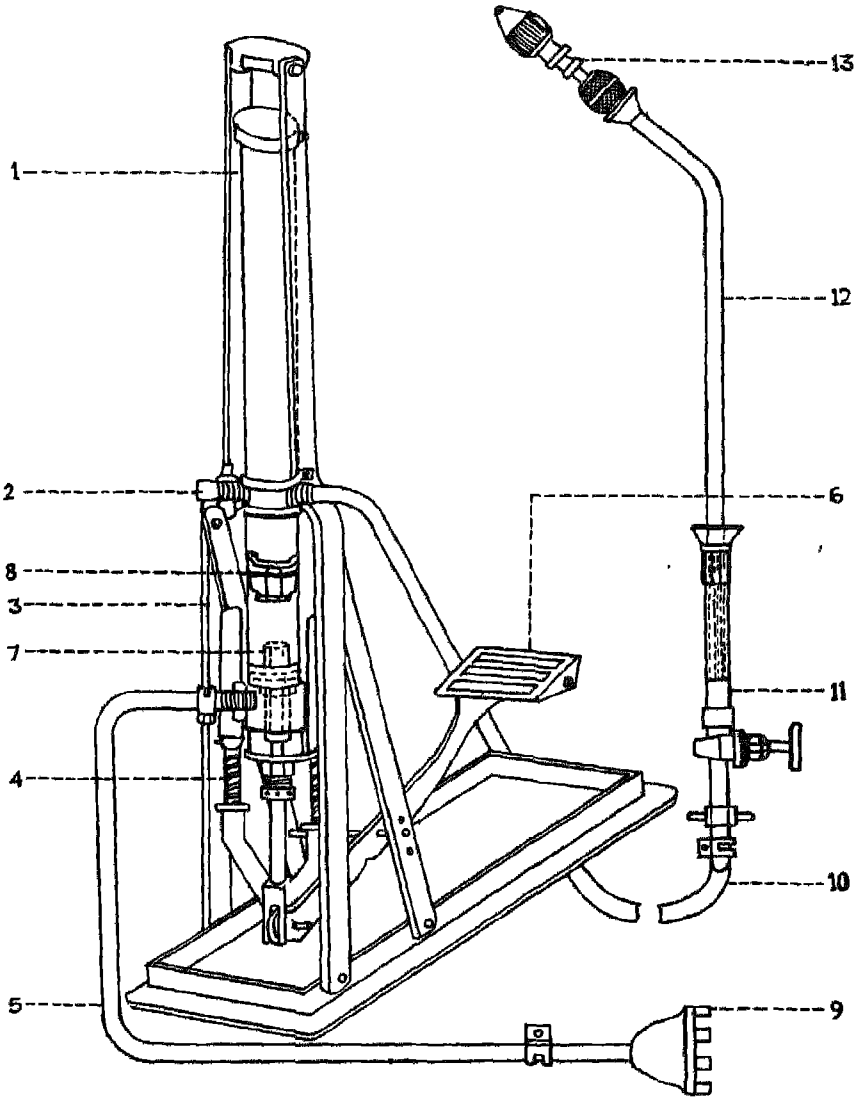


Fig. 2 Manually operated hydraulic-energy foot sprayer with a hydraulic pump.

1—pressure assembly, 2—closed delivery spout, 3—stand, 4—return spring, 5—suction hose, 6—pedal, 7—suction-valve assembly, 8—delivery-valve assembly, 9—strainer, 10—delivery hose, 11—wheel cut-off valve with strainer, 12-spray lance, 13—nozzle.

or bean shaped tank, with a filling capacity of usually 10-14 litres. This sprayer has a pump and a pressure or chamber barrel having a piston pump and a mechanical agitator. The spray line consists of a short rubber pipe, a lance and a nozzle. The settling of wettable powders in the tank of the sprayer is prevented in many cases by the provision of a mechanical agitator. The pressure of 3-5 kg/cm^2 can be maintained in most cases without much efforts. The sprayer can be used for spraying low crops, vegetables, nursery stocks and shrubs and trees upto 2.5 m height.

2. *Foot sprayer* (Fig.2)

It is also called pedal pump, pressure sprayer or hyjet sprayer. It consists of a plunger assembly, a stand, a suction hose, a delivery hose, an extension rod with a spray nozzle. etc. One end of the suction hose is fitted with a strainer and the other with a flexible coupling. Similarly the delivery hose has one end fitted with a cut-off valve and the other with a flexible coupling. It is operated by foot instead of hand. Constant pedalling is required for continuous spraying. It develops a pressure of 17-21kg/cm^2. It can be used for spraying tall crops as well as fruit trees upto 4 m height. With a single nozzle it can spray about 1 ha of a medium sized crop in a day.

3. *Rocking sprayer* (Fig.3)

It consists of a pump assembly, a platform, an operating lever, a pressure chamber, a suction hose with a strainer, a delivery hose, extension rod with a spray nozzle etc. A high pressure of 14-18 kg/cm^2 can be built up in the tank. It can be used for spraying tall field crops and trees upto 5 m height. A high pressure should always be maintained for uniform spraying.

Dusters

Dusting machines are appliances which enable pesticidal powders to be applied over plant or soil surfaces. Dusters are much less complicated than sprayers.

In dusters, either a current of air is blown, which picks up the dust or the dust is fed into the air current which carries it outside either horizontally or vertically for depositing on the surface.

Dusters are available in different models :

1. Below type
2. Piston type
3. Knapsack type
4. Rotary type
5. Power dusters

The two important types which are most commonly used are described below :

1 *Plunger duster* (Fig 4.)

It consists of an air pump of the simple plunger type, a dust chamber and a discharge assembly consisting of a straight tube or a small exit pipe whose discharge outlet can be increased or decreased by moving the lid provided at the end of a dust chamber The con-

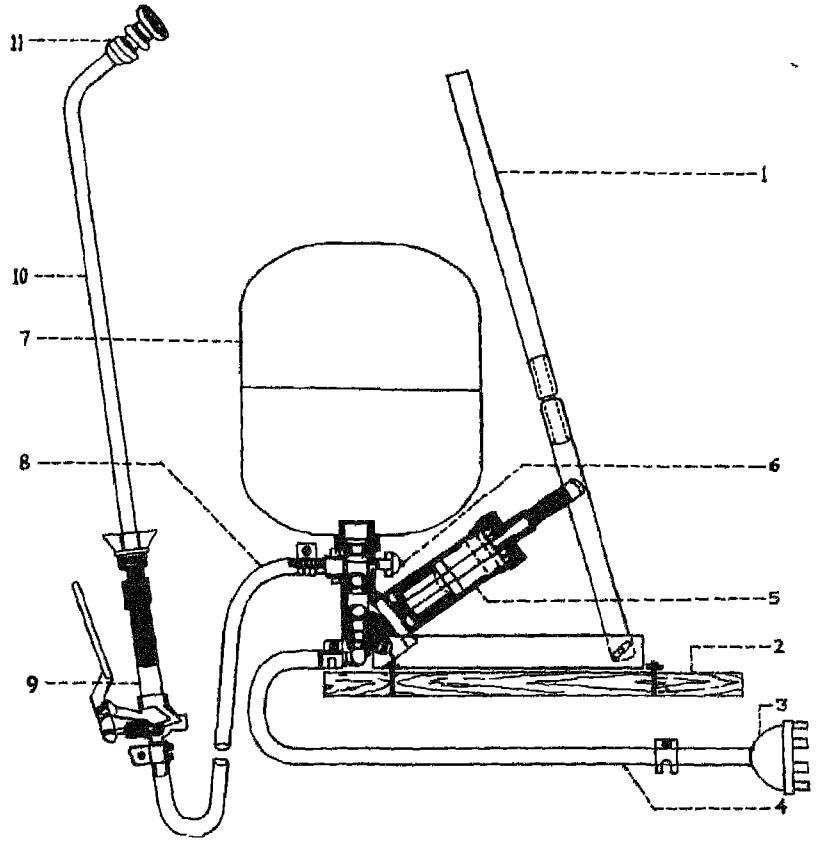


Fig. 3 Manually operated hydraulic-energy rocking sprayer with a hydraulic pump

1—lever, 2—platform, 3—strainer, 4—suction hose, 5—pump assembly, 6—closed deliver-spout, 7—pressure vessel, 8—delivery hose, 9—trigger cut-off valve with strainer, 10—spray lance, 11—nozzle

tainer is generally cylindrical with a detachable lid, for filling in the dust. The air from the pumps is directed through a tube into the container where it agitates the dust and ejects it from a discharge orifice or tube. The amount of dust applied can be controlled by speed at which the pump is operated.

Advantage : These are cheap and easy to operate and suitable for household and kitchen gardens.

2. *Rotary duster* (Fig. 5)

A rotary duster consists basically of a blower complete with gear box and a hopper. It is operated by rotating the

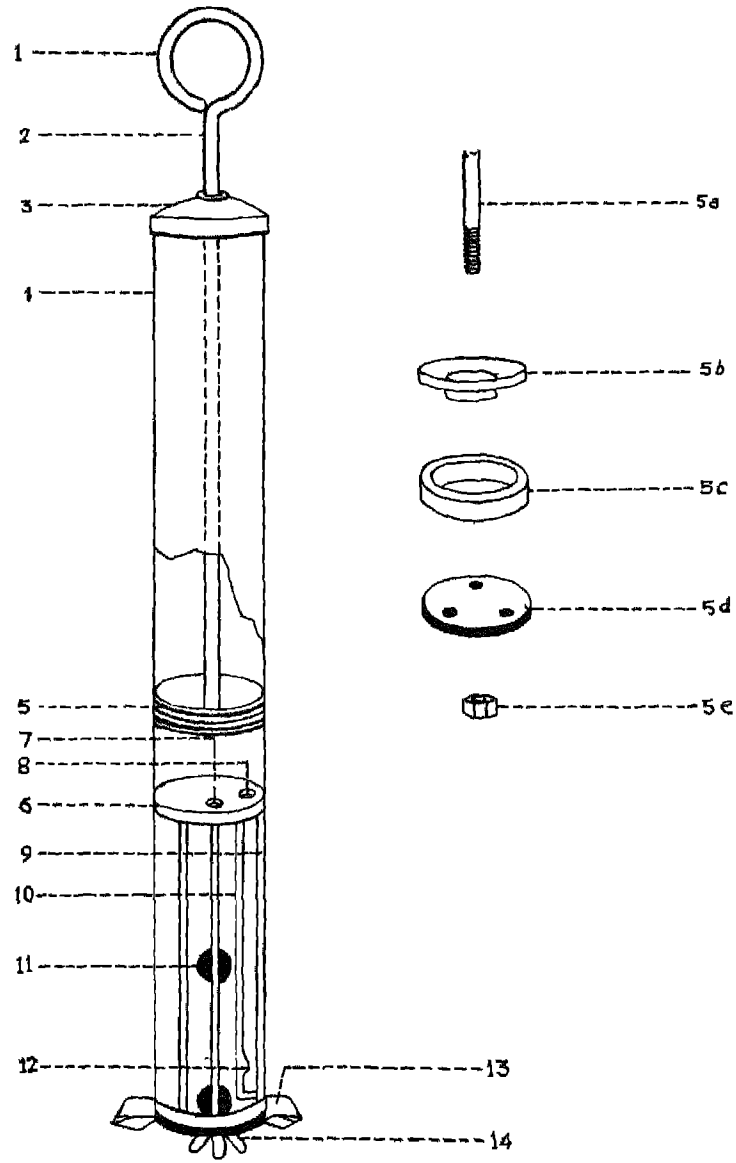


Fig 4 Plunger duster.

A. 1—handle, 2—plunger rod 3—cap for pump cylinder, 4—pump cylinder, 5—plunger bucket assembly, 5a—lower protion of plunger rod, 5b—upper plate, 5c—plunger bucket, 5d—lower plate, 5e—nut, 6—partition plate, 7—wire-gauzed hole, 8—air inlet hole, 9—dust chamber 10—blow pipe, 11—wire-gauzed dust exit hole, 12—air discharge hole, 13—lid, 14—wing-nut

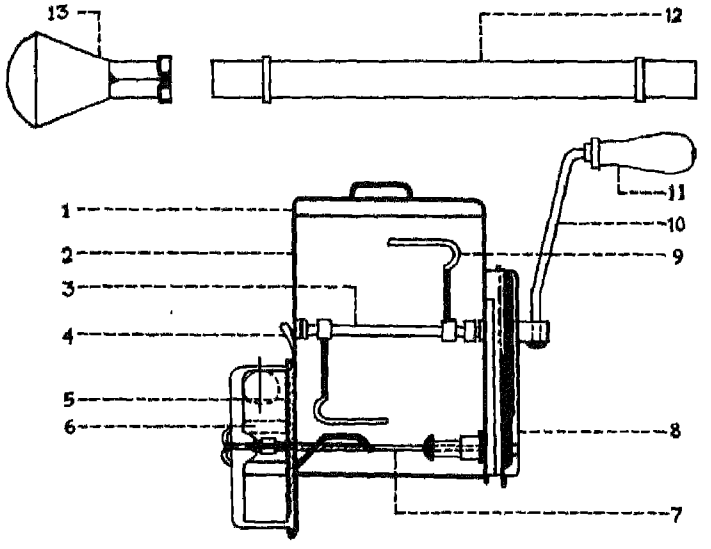


Fig 5 Manually operated belly carried rotary duster.

1—lid, 2—hopper, 3—agitating-shaft, 4—feed-control lever, 5—dust outlet, 6—blower, 7—blower shaft, 8—gear-box, 9—agitator, 10—crank, 11—handle, 12—lance, 13—nozzle.

crank. The cranking motion is transmitted through the gear box to the blower. A drive is taken off for the dust agitator located in the hopper. The rotary dusters may be hand carried, or shoulder mounted or belly carried. The average weight of the emply rotary duster is around 6.5 kg. and the capacity of hopper is generally about 5 kg.

Advantage: A rotary duster has simple construction and if it is regularly serviced and properly maintained, it gives trouble free efficient service.

7.2 Precautions

- Do not fill the chamber/tube fully with the pesticide material. It should not be filled beyond ¾ of its capacity.
- Clean the equipment properly and regularly. Oiling, lubrication etc and replacement of worn out parts should be a regular practice.
- Carefully read and follow the instructions given by manufacturers for each type of equipment.
- Use clear water for flushing as well as preparing spray fluids.
- Do not use mouth to clean the clogged nozzles.
- Do not let the nozzles or other outlet parts fall to the ground to be clogged or damaged.

7.3 Materials required

1. Any plant protection equipment :
   (a) a sprayer — knapsack or foot sprayer
   (b) a duster — rotary duster.
2. Spares and accessories — like gaskets, valves, hosepipes, nozzles etc.
3. Grease, oil and other lubricants.
4. Various tools particularly spanners, wrenches, screw-drivers, plier, hammer, bolts and nuts, screws, binding wires etc.
5. Packing materials — cotton yarn, jute, safeda (ZnO)
6. Pesticide formulations — EC, dusts, etc.
7. Water, talc and other diluents.

7.4 Procedure

7.4.1 *Handling Ref. AU: 11.*

7.4.2 *Maintenance*

— Ascertain the nature of pesticide to be used i.e. whether it is corrosive to the metal used in construction of the plant protection equipment.

— Check equipment prior to its use and replace worn out parts.

— Keep ready stock of spares, which usually wear out, as replacements.

— Clean all equipment properly after use and store in a dry place.

— Grease the screws, nuts, bolts, piston assembly, shaft, bearings, valve, agitator, plungers, washers etc.

— Maintain the required pressure to get a thorough coverage.

— Empty the spray tank/hosepipe etc. after use.

— Wash profusely all machines with water immediately after use.

— Dry the machine after cleaning and wrap the hose pipe with any suitable material i.e. hussain cloth etc. to avoid any damage in the storage.

— Change used oil in the power driven equipments and maintain oil at the required level.

— Take all care while shifting/transporting equipment from one place to other.

7.5 Questions

1. What are plant protection equipment?
2. What is a sprayer?
3. What is a duster?
4. What is an insecticide?
5. What is a fungicide?
6. What are the advantages of a spray? Under what situation is it to be used?
7. Describe a foot sprayer.
8. What are the precautions in handling the plant protection equipment?
9. How are the plant protection equipment maintained?

8. Activity Unit

PREPARATION OF PLANT PROTECTION EQUIPMENT FOR OPERATION

8.1 Relevant information

Choice of a plant protection equipment depends on several factors, such as the type and nature of pest, type of pesticide available for use, situation under which it is to be used like small kitchen garden, large field area, orchard, storage godown etc.

Preparation of the equipment is necessary so that it is used efficiently under the given situation against the target pest. Preparation involves checking the equipment for any leakage, worn out parts and their replacement and checking for proper functioning.

Advantages: Checking the plant protection equipment before putting to operaton in the field has several advantages:

(1) It saves the operators from possible toxic contamination through leakage or spillage.
(2) Saves the time involved in repairing the equipment in the course of use.
(3) Saves the wastage of costly and toxic pesticides.

Points to be taken care of

(1) Suitability of plant protection equipment.
(2) Systematic check up for any leakage.
(3) Provision of spares which usually get worn out such as washers, gaskets, hose pipe, nozzles etc.

Different types of pesticides are available for soil application, seed dressing, foliar application, application in specific situations such as closed environment, marshy places, tree tops etc. These are, therefore, transformed into different formulations such as dusts, emulsifiable concentrate wettable powder, granule, solution fumigants etc. For applying different formulations, differal plant protection equipment are required.

Distribution of pesticide over a specified area in required quantities which are usually small, is possible only when the equipment is calibrated for use i.e. it is standardised to deliver the specific required quantity over the area. The rate of application of spray fluid per unit area is regulated by four factors—(i) Operating pressure, (ii) Size of nozzle aperture, (iii) The swath width and (iv) Speed of the operator.

8.2 Precautions

— Check the plant protection equipment for any leakage before use.
— Clean and wash plant protection equipment before and after use for, any contamination occurring due to any pesticide.
— Do not leave the equipment filled for long periods after and during the use else they may cause corrosion or damage soft rubber/plastic parts.
— Do not fill the tanks beyond ¾ th of the capacity.

8.3 Materials required

1. (a) A foot sprayer (b) A rotary duster.
2. Spares — usually those which get worn out easily and need replacements like washers, gaskets, hose pipe, nozzles.
3. Pesticide chemicals — Emulsifiable concentrates, (EC), dust of any insecticide
4. Diluent materials — water talc etc.
5. Accessories like buckets, water containers, measuring devices.

8.4 Procedure

8.4.a. For foot sprayer

8.4.a.1 Equipment

— Get a foot sprayer.
— Examine the situation under which the foot sprayer is to be used i.e. field crops, trees in an orchard etc.
— Select suitable size of nozzle — a hydraulic energy nozzle of any type like flat fan, hollow cone or soild cone or jet or solid stream nozzle (a simple exit hole or a tube designed for producing a jet that finally shatters into coarse drops.
— Arrange for accessories required like water cantainers, bucket, strainers etc.
— Handle and maintain the sprayer in working condition (Refer 7)

8.4.a.2 Chemicals (Pesticides)

— Select suitable pesticide emulsifiable concentrate of standard content and of valid period.
— Examine container for any leakage.
— Read label and instructions carefully.
— Dilute the E.C. to required application strength (Refer 9.4.2.).
— Fill the bucket with the solution in required amount.
— Agitate/stirr the diluted material occasionally to have a homogenous solution (usually emulsions have the properties to keep the toxicant distributed in the diluent but long time intervals lead the solids to settle down). This can also be done through passing the discharged material into the container again and again for a few minutes.

8.4.a.3 Calibration

— Read carefully the instructions provided by the manufacturer setting out various combinations which may be used for a particular application rate. This may be relied upon when the machine is new.

— Check calibration against manufacture data after some time since constant use may wear out the nozzles etc. which affect the correct discharge.

— Calibrate the equipment every time before use.

— Mark an area of 2.5. m. × 4 m.

— Fill the container and discharge tube of the sprayer with water.

— Mark the level of water in the container and spray the area.

— Now refill the container to the original level with known volume of water.

— Calculate the rate of delivery in l/ha by multiplying the volume of water in litres used in spraying by 1000, or

— Calculate volume of water used to spray the above area in the time required and the discharge of the nozzle per unit time.

Note: Constant speed of an operator is important since changing the speed will change the rate of spray application.

Rate of discharge can also be changed by replacing the nozzle and within certain limits, by increasing or decreasing the pressure.

8.4.a.4 Filling and loading

— Take a known volume of water in the bucket.

— Measure the quantity of the emulsifiable concentrate required and put into the bucket.

— Agitate/stirr the emulsion in the bucket.

— Put the inlet end in the bucket and generate pressure with the peddle provided on a foot sprayer and let the liquid fall into the bucket. This will also help in agitating the fluid.

— Direct spray towards the target.

8.4.a.5 Observations

— Record the number of insects before the spray.

— Note the symptoms of disease and area of infection before spray.

— Observe population of insects or infected disease area after specified time.

— Calculate effectiveness of the application treatment by working out per cent mortality of insects or reduction of the diseased spots/plants.

8.4.b For rotary hand duster

28.4.b.1 Equipment: A rotary hand duster

— Select the hand rotary duster for application of dust in the field for

chewing insects.
- Arrange for spares like—gaskets used for joining delivery pipe with the body and the outlet.
- Handle and maintain the duster in working condition
(Ref. Au 7)

8.4.b.2 Dust
- Select suitable dust of standard content and of valid period.
- Examine bag or packet for any leakage.
- Read label and instructions carefully.
- Fill up the container with the dust of the required strength.
- Dilute the high content dust to the required strength by adding diluents like talc which may occasionally be required to increase the volume.

8.4.b.3 Calibration
Follow procedure given for a foot sprayer.

8.4.b.4 Filling, loading and operation
- Weigh the required quantity of dust
- Fill the container through inlet hole and close the lid.
- Mount the duster on the applicators body.
- Operate the duster with the handle directing the outlet down towards the target substrate i.e. crop or floor or soil.

8.4.b.5 Observation
(i) Follow steps given earlier under the first sprayer.

8.5 Questions
1. What considerations are required in selecting a plant protection equipment?
2. What precautions are to be kept in mind while using a plant protection equipment?
3. What is calibration of equipment?
4. How is a sprayer is calibrated for use?

9. Activity Unit

PREPARATION OF WORKING SOLUTIONS OF PLANT PROTECTION CHEMICALS FOR APPLICATION

9.1 Relevant information

Most plant protection chemicals are deadly poisonous. These are effective in controlling various pests at very low concentrations. Their use in the pure form is dangerous because of the highly poisonous nature and difficulty in handling such concentrated products. The packaging, transportation and storage of these materials in highly concentrated forms is also dangerous and risky. These are, therefore, suitably formulated in to lower concentrations before use. The formulation puts these products in a form which is easy to handle, store, transport and apply.

Depending on the physico-chemical characters of these products and their form needed for use, these are formulated in liquid or solid forms. The common liquid formulations are: solutions (The toxicant dissolved in a solvent), emulsifiable concentrates (Comprising toxicant, solvent and emulsifier . The emulsifier enables the formation of emulsion when these materials are diluted with water), wet flowables (Dispersions of toxicants in water with the help of dispersing agents. These are diluted with water before use). The common solid formulations are: dusts (A powder containing toxicant with a filler), water dispersible powder (Toxicant + Filler + Dispersing agent. It forms suspensions when diluted with water), granules (Containing Toxicant + Filler + Binder. Suitably prepared as granule of different sizes), dry flowables (Constituted by water dispersible granules) etc.

All the formulations contain a known concentration of the toxicant. Those formulations which have high concentration are diluted to the desired concentration at the time of use.

Advantages

The dilution of the formulations to the desired use concentration serves many useful purposes such as:

1. It provides a concentration which is able to do the desired job effectively without much wastage.
2. The lower concentrations are safer for the operators to handle.
3. The undue contamination of the

vironment is avoided.

4. It avoids the development of pest resistance to pesticides which develops as a result of the use of higher doses of toxicants. (in case of indescriminate use).
5. The toxic residues do not affect the succeeding crops.

9.2 Precautions

— Read the instructions given on the label of the container carefully for use.
— Calculate the concentration and dilution ratios carefully.
— Use gloves and facial masks while handling toxicants.
— The empty containers need to be destroyed.
— The containers once opened should not be kept at a place which is within the reach of children and pets.

9.3 Materials required

1. Emulsifiable concentrates e.g. Malathian 50 EC, Endosulfan 35 EC.
2. Some active ingredients e.g. Tech. DDT, Tech. Carbaryl etc. for preparing solution concentrates.
3. Dusts e.g. 5% BHC dust, 5% Aldrin dust
4. Water Dispersible Powders e.g. 50% DDT-WDP, 50 Malathian — WDP.
5. Granules e.g. 10% Phorate granules.
6. Solvents, like acetone, mineral oil etc.
7. Diluent — water, talc etc.
8. Glasswares — like volumetic flasks of different capacity, reagent bottles
9. Wt. box, balance
10. Filter paper
11. Vacuopet

9.4 Procedures

9.4.1 *Preparation of a 10% Solution Concentrate and its dilution to the desired concentrations.*

— Weigh 10g of the given active ingredient.
— Tranfer it to a 100 ml volumetric flask.
— Dissolve the active ingredient in a small amount of the solvent in which it is soluble.
— Check that the solution is clear.
— Filter if there is any impurity.
— Wash the residue on the filter paper with the solvent.
— Make volume with the solvent to 100 ml.
— From the above prepared solution. prepare 1%, 0.1%, 0.01% etc. concentrations as follows.

1% : Take 10 ml of the 10% solution with a measuring cylinder and dilute to 100 ml. with the solvent.

0.1% : Take 10ml of the 1% solution with a measuring cylinder and dilute to 100ml with the solvent.

0.01% : Take 10ml of the 0.1% solution with a measuring cylinder and dilute to 100ml with the solvent.

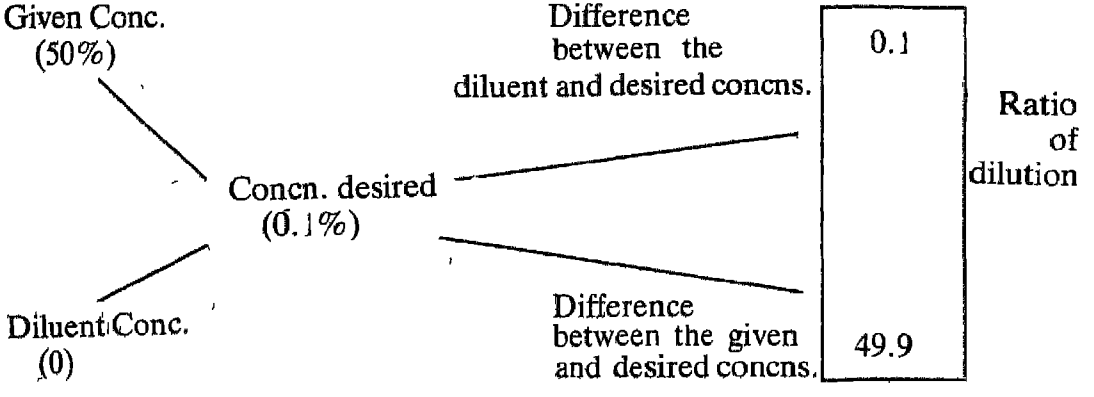
Note:- 1. When you make very low concentrations from a high concentration solution, then quite often, its very low volumes have to be taken. Measuring very low volumes can cause error. Therefore, use a solution of appropriate strength only.

2. While preparing solutions of toxicants, do not use mouth. Use a measuring cylinder of appropriate volume.

9.4.2 *Dilution of an emulsifiable concentrate*

Suppose you have to prepare one litre of a 0.1% emulsion from a 50% Malathian E.C., proceed as follows:

Calculate the Dilution Ratio as follows.



Ratio of dilution in the above example is:

0.1 : 49.9

or

1 : 499

i.e. Take 1 ml of the 50% E.C. and make 500 ml with water or take 2 ml of the 50% E.C. and make 1L with water.

The dilutions may also be calculated as follows:

$$V_1 C_1 = V_2 C_2$$

Where

V_1 = Volume of the E.C. to be taken—?

C_1 = Concentration of the E.C.

V_2 = Final volume after dilution (to be made)

C_2 = Concentration desired

In the present case.

$C_1 = 50\%$

$V_2 = 1$L or 1000 ml.

$C_2 = 0.1\%$

$V_1 = ?$

Now putting these values in the above expression.

$$V_1\ 50 = 1000 \times 0.1$$

$$V_1 = \frac{1000 \times 0.1}{50} = 2.0 \text{ ml}$$

i.e. Take 2 ml of the 50% EC and make 1000 ml or L volume with water.

9.4.3 *Dilution of a dust concentrate*

If you have a ready to use dust of 5 - 10% strength, it may not be diluted as this can be applied as such. However, if a dust concentrate is given, then it is to be diluted to the required concentration before use. The calculation can be done by any of the methods given in 2.4.2 above. Take the required weight of the dust concentrate and add to it the calculated amount of the diluent (filler). Mix, thoroughly in rotary drum.

Suppose the given dust concentrate (C1) is 20%

The desired concn. (C_2) = 2%

Quantity to be made (V_2) = 200 kg.

The quantity of dust concn. to eb taken (V^1) = ?

$$V_1 C_1 = V_2 C_2$$

$$V_1 20 = 200.2.$$

$$V_1 = \frac{200 \times 2}{20} = 20$$

i.e. Take 20 kg of 20% dust concentrate. Add to it 180 kg of the diluent or filler. Mix these thoroughly to obtain a uniform concentration.

9.4.4 *Dilution of a water dispersible powder*

- Calculate the amount of the given water dispersible powder required to obtain the desired concentration and quantity (Refer 2.4.2.) for application.
- Add a small amount of water to this powder and make a paste by slowly stirring it.
- While stirring, add the balance quantity of water.

9.5 Questions

1. Why are pesticide formulations generally diluted before use?
2. What are the different ways of calculating dilutions of the given formulation before use?
3. Enunciate the advantages of applying only the desired concentrations of toxicants.

10. Activity Unit

PREPARATION AND APPLICATION OF BORDEAUX PASTE

10.1 Relevant information

In 1887 Prof. P.N.A. Millardet of the University of Bordeaux in France discovered a formulation 'Bovillie Bordelaise' commonly known as Bordeaux Mixture. It was based on a chance observation made in 1882 by Prof. Millardet who found that a poisonous looking mixture of copper sulphate and lime used by farmers in Medoc (France) to frighten school boys from pilfering grapes, controlled the destructive downy meldew *Plasmopara viticola* also.

The American Phytopathological Society Committee on Standardization of Fungicide Tests published the following method of comparing the Boardeaux standard and 'unknown fungicides'.

The temperature of preparing and storing standard Bordeaux mixture should be 20-25°C.

Stock $CuSO^4$: A 3.928 % solution of reagent grade $CuSo_4.5H_2O$ (1.0% Cu) is made in distilled water.

Stock lime-water : A saturated lime watersolution is prepared by suspending an excess of reagent grade hydrated lime in boiled destilled water. Agitate thoroughly to attain saturation. Allow it to settle. Keep in siphon bottle protected from Co_2 with soda lime tower.

Standard Bordeaux Mixture : The volume ratio of stock copper sulphate and lime water should be 1 : 12 (Molecule ratio of 1 Cu to 1.65 Ca) The stock copper sulphate should be added to the stock lime-water while stirring. The quantities in ml. of stock copper sulphate solution to be added to stock lime-water and diluted to obtain varying percentage of copper are given in the following table.

Table : Quantities of stock copper sulphate solution to be added to stock lime water and the final volume to be made.

Copper (%	Final Volume : 250 ml		500 ml		1000 ml	
	Cu	Lime	Cu	Lime	Cu	Lime
0.02	5	60	10	120	20	240
0 01	2.5	30	5	60	10	120
0.005	1.25	15	2.5	30	5	60

Advantages

1. It controls effectively the potato blights.

2. It is effective against a number of diseases of fruits, vegetables, rubber, maize, coconut, betel leaf, turmeric, colocasia etc.

10.2 Precautions

- Prepare fresh before use.
- Under any circumstances, use within 24 hrs.
- Avoid excess of carbonates in the mixture.

10.3 Materials required

Copper sulphate ($CuSO^4.5$ HO)
Hydrated lime
Water

10.4 Procedure

- Prepare a stock solution of $CuSO^4.5H_2O$ providing 1.0% Cu in water (A)
- Prepare a saturated stock lime water solution (B)
- Work out the volumes of (A) and (B) to be taken for preparing the required volume.
- While stirring, add (A) to (B).
- Make volume with water. Stirr thoroughly.
- Spray on a fungi infected plant.

10.5 Questions

1. What is Bordeaux mixture ? How was it discovered ?
2. How is the Bordeaux standard prepared ? Enunciate the precautions to be taken during its preparation and use.
3. Can we prepare Bordeaux mixture in any metallic container? If not, why?
4. Is it possible to prepare Bordeaux paste using appropriate materials ? What uses of this paste you can think of ?
5. Why should Bordeaux mixture be used soon after its preparation?

11. Activity Unit

APPLICATION OF PLANT PROTECTION CHEMICALS

11.1 Relevant information

After the desired dilutions of the plant protection products have been prepared and loaded in the plant protection equipment, the next important aspect is the application of the material under field conditions. A thorough application is vital for the effectiveness of the material. It is desirable to ensure that all pesticide droplets and particles evenly cover the area to be treated. A careless application is apt to result in more losses as also build up of toxic residues.

Advantages

1. Application of plant protection chemicals enables a timely control of the harmful pests; thus saving the crop from pest damage.
2. Some of the chemicals cause growth promoting effects on the plants.

11.2 Precautions

- Do not carry out spraying or dusting against the direction of the wind.
- Conduct the operation in the mornings or evenings only, when the atmosphere is calm.
- Always keep in mind the hazards due to toxicant drift. Grazing animals in the vicinity be avoided.
- Guard against pesticide run off into sources of water supply.
- Give a time lag to edible crops between application and their harvest for consumption.
- Never use mouth to open clogged lines or nozzles.
- Avoid exposure of cut or wound on the body to the pesticide.
- The baits for rat control etc. be kept out of reach of children, pets and other useful creatures.

11.3 Materials required

Sprayer: Any one of the sprayers as listed in Au-7

Dusters: Any one of the dusters as listed in Au-7

Emulsifiable concentrates: Emulsifiable concentrate formulations such as Malathion EC, Fenvalerate EC, Endosulfan EC etc.

Wettable Powders: Disperisible powders such as: carbaryl WDP, Malathion WDP etc.

Dusts: e.g. BHC and aldrin dusting powders.

Field: A test plot or a field with a crop raised in it.

11.4 Procedures

- Identify the pest and decide the pesticide to be used.
- Prepare the required concentration and quantity of the emulsion, suspension, dust etc. from an emulsifable concentrate formulation or water dispersible powder or dust as per details given in Preparation of Working Solutions Materials for Application (AU-9)
- Calibrate equipment to disperse the desired amount of the pesticide per unit area.
- Fill emulsion or suspension in a sprayer and dust in a duster as per details given under Preparation of Plant Protection Equipment (AU-8)
- Put the equipment in its application position i.e. it may be put on the shoulder or in any other position in which it is to be used.
- Mark the area to be treated.
- Conduct the operation following the precautions given above.
- Cover both the upper and the lower surface of the plant leaves, or of the other parts being treated.
- Observe spray for uniformity of deposit and coverage on the treated surface.

11.5 Questions

1. Why is a thorough coverage of the infected plants vital in plant protection?
2. What precautions would you take while applying plant protection chemical?
3. How can we increase the efficacy of application of pp chemicals?
4. How important are the weather conditions in taking any pp measures?
5. What are the possible ways in which a person can be adversely affected while using pp chemicals?
6. Can one and the same chemical be used for both spraying and dusting?
7. Which is more effective — dusting or spraying?

12. Activity Unit

SAFE STORAGE OF GRAINS

12.1 Relevant information

As per the popular government logo, grain saved is grain produced. So every caution should be taken to save the grain from damage. A number of factors such as moisture content, foreign material, insects, micro-organisms etc. damage the grains during storage. Every care needs to be taken to favourably control the various factors for safe storage of grains.

High moisture makes the grain highly susceptible to pests. The grain with very low moisture content below the required level have reduced viability or grain germination. Moisture level of the environment can also damage grains because during rainfall grains are liable to absorb moisture from the surroundings. This has to be avoided by use of good storage bins. Good storage bins prevent the outside moisture from entering into the bins and thus, keep the grains dry.

Store grain diseases:

Grains with moisture level higher than 10% are liable to be attacked by a number of diseases such as:-

1. *Black point of wheat:* During the rainy season, the diseased seeds spread micro organisms to other seeds. Pointed side i.e. embryo side of the grain is damaged.
2. *Tundu tearcockle of wheat*: Galls or partial galls remain mixed with seeds. These help in damaging the surrounding seeds.
3. *Purple seed of soybean:* Partially or wholly, the soybean seeds become stained purple colour. During high temperature of summer such seeds emit some harmful gases which damage the other seeds as well as the consumers.
4. *Moulds:* Fungi like Aspergillus sp. very frequently attack the damaged seeds. These may be associated with the production of some toxins also as in case of groundnut.
5. *Ergot of Jowar and bajra:* The affected grains remain mixed with other grains and damage them during rainy season when the moisture content in the atmosphere is high.
6. *Brownspot of Paddy*: The fungus produces brown spots in seed kernals. It spreads during high moisture conditions prevalent during the rainy season.

Store grain insect-pests:

Several insect pests like khapra, rice weevil, flour beetle, lesser grain borer,

rice moth, grain moth, pulse beetles etc. also attack grains in storage. The nature of damage is briefly given below:

Insect	*Description*
Khapra	A brown oval beetle whose grubs damage grains of all types. In the initial stages infestation is restricted to top layer but spreads to entire stock in severe cases. The grub is brownish white with bundles of reddish brown hair all around the body.
Rice weevil	A small reddish brown or black weevil with snout; both adult and grub feed on all cereals, the grub bores into the kernel.
Flour beetle	A reddish brown beetle and its pale yellow grub feed on broken grains and flour of cereals.
Lesser grain borer	A dirty white grub with tiny hairy and curved body that bores the grain; adult is a cylindrical dark brown beetle with roughened body surface.
Rice moth	A dark gray moth which may lay eggs anywhere during storage while catterpillars feed on broken grains and bore holes in the whole grain and construct silken web entangled with bits of grain.
Grain moth	A small yellowish brown moth with fringed wings; caterpillars bore into grains and make them hollow.
Pulse beetle	Chocolate coloured beetle whose adults and and grubs damage various types of pulses in storage as well as in the field.

Therefore grain must be dried properly before storage.

If plant debris and soil particles are left with grains the plant parts will rot first and damage the grains around them. These can be removed by strainers or grain separators.

The main component of safe storage is protection against insects. Use of fumigants (insecticides) helps in keeping the grains free from insects for quite a long period.

Storage receptacles:

Storage of grains in different types of receptacles provides a cheap and easy way to protect them from pest damage. The prevalent storage receptacles are:

1. Mud bins and kothi
2. Metal drums and bins
3. Underground structures
4. Stone and masonry structures
5. Silos
6. Cloth and gunny bags.

Small receptacles like earthen pots, mud bins and kothis, Pusa bin, metal containers, drums and bins, Hapur

bins, khotis, and stone structures besides cloth and gunny bags are very popular in the villages and amongst the city dwellers. Large sized structures are preferred by Ware-Housing Corporation, Food Corporation of India and similar such agencies.

The scientific methods of preserving grains in small quantities lie in the use of metal drums (Hapur bin) improvised or Mud kothi (Pusa bin).

Pusa bin consists of embedding a 70mm polythene sheet in between the brick wall on all sides except the outlet of 15cm on one side and inlet hole of 50×50 cm on the top. However, these holes are also plugged with polythene sheet attached to a frame. The purpose of all this is to make the walls impervious to exchange of air and moisture. The size of the bin may vary according to the capacity required i.e. 2 to 20 Q. The walls all around are made pucca with bricks upto a height of 30-45cm from the ground so that it can be kept safe from the damage of rats.

However, to make best use of Pusa bin, it should be filled completely with the grain. If it is not possible, fill dry bhusa in the remaining space. It should be sealed properly immediately after and should not be opened during wet season.

Advantages

1. Proper storage helps in keeping the grain free from pest damage.
2. Healthy and uninfected grain fetches better price.
3. Germination of the seed can be improved.

12.2 Precautions

— Do not store grains loose.
— Do not mix infested and healthy grains together.
— Clean grains free of dirt and plant materials.
— Do not store grains with moisture content higher than 10%.
— Always keep storage receptacles in cool, dry place, free from humidity.
— Seal structure properly to make it air tight.
— Do not mix pesticide with grains meant for consumption.

12.3 Materials required

1. Grain—wheat
2. Any storage structure/receptacles metallic bin/Pusa bin.
3. Fumigant—methyl bromide, ED/CT or EDB ampules. Insecticides — Malathion dust, 5%.
4. Moisture meter, strainer
5. Sealing material—wax, mud etc.
6. Earthen bowls to keep fumigants

12.4 Procedure

12.4.1 *(A) Storage of grains* (for consumption purpose)

— Clean grains of the foreign materials like mud/stone particles and plant materials.
— Dry grain properly in the sun.

— Sort out damaged and broken grains.
— Examine the moisture content (It should be lower than 10%). (Note: In the absence of a grain moisture meter, the simple test of putting the grains under teeth may provide an idea about the moisture contact).
— Check storage receptacles for any gaps, cracks and crevices and seal them properly.
— Treat structures/receptacles with insecticides/fungicides to make them free from the infestation of insects and micro organisms.
— Fill dry grains in the structure and seal the inlet hole properly.
— Put the storage structure in dry but shady place free from high humidity.
— Examine the structure periodically for any cracks etc. developing because of the load of the grain and temperature and other environmental fluctuations.
— Open the structure very rarely else the chances of insect infestation through air exchange or increase in moisture will result.
— If infestation is observed, treat grains with any of the fungicides at the recommended dose.
— Insecticide/fungicide should not be mixed with the grain meant for human consumption.

12.4.2 (B) *Seed storage*

— Follow above mentioned steps.
— Treat seed with insecticides/fungicides to avoid any possible infestation/infection.

Questions

1. What organisms damage grains in storage?
2. What are the different storage structures/receptacles?
3. What precautions are required in storage of grains?
4. Why pesticides should not be mixed with grains?
5. Why is it not safe to consume the grains damaged during storage?
6. Why loose storage of grains is not recommended?
7. Is it cheaper and better to store grains in gunny bags than in standard storage bins?
8. How can we detect infection/infestation of grains during storage?
9. Can we store different types of grains under one roof?
10. You store wheat grains, rice, pulses and wheat flour in separate containers. Which of these is most vulnerable to pests/diseases? Give reasons.

13. Activity Unit

MECHANICAL CONTROL OF PEST-DISEASES

13.1 Relevant information

Mechanical conrtol is very effective way of controlling diseases and insect-pests. Mechanical control includes;

a. *For diseases*
   (i) Rogueing
   (ii) Hand picking
   (iii) Plant surgery
   (iv) Sanitation and
   (v) Cultural control

b. *For insects*
   (i) Use of Light traps and other traps
   (ii) Hand picking
   (iii) Burning of trashes
   (iv) Trash-removal and clean cultivation
   (v) Sound production and sound devises
   (vi) Colour bands
   (vii) Use of machanical killers/ instruments
   (viii) Shacking of plant

Rogueing

Diseased plants or insect infested plants are removed from the field and destroyed. This way the disease or insect-pest can be destroyed from the source and further spread is avoided, e.g. virus affected plants,

Hand Picking

Diseased leaves and insect bearing twigs can be removed in the initial stage when the diseases/insects have just infested it. Such picked parts are destroyed and thus, the insects/diseases are also distroyed.

Plant Surgery

Big trees or very small plants when they are partially affected by disease or insect, such portion or such part is removed with knife and the spot is treated with toxic chemicals so that the rotting or further damage does not take place. It is more important in case of fruit trees.

Sanitation

Diseased or rotten plant parts, weeds etc which may serve as source of diseases and insects are destroyed so that diseases or insects occurring on them do not spread further.

Cultural control

Inter culture operations when done timely kill or expose the hidden enemies of plant. When these enemies are exposed they are eaten up by others or damaged by sunlight or environmental conditions.

Use of light traps:

Light trap attracts insects of the area where it is fixed. Such insects are trapped in a cage or dropped on paper sheets provided with stickers. Insects stick to these and get killed. This operation when done during the breeding season or egg laying period traps the mother insects and thus further progeny of insects is avoided.

Moth, butterflies, leaf hoppers are easily attracted to light traps.

Hand picking

Big larvae and aphid or caterpillar colony sticking to plant parts like leaves are destroyed by destroying such leaves. Pupae or cocoons of insects sticking to plant parts during hibernation can be destroyed. This will help in checking the multiplication of such insects.

Burning of trashes

Plant trashes particularly after harvest of crop or ratooning can be burnt without much efforts. Hiding insects, their pupae are burnt alongwith trusher. Stem borer of sugercane and sorghum are good examples of this. In case of fruit trees the insects hibernate below the ground hiding in the fallen leaves. If leaves are burnt the insects disease organisms shall also be burnt. When trashes are burnt in field the temperature of surface also increases. Grubs hiding below soil layer are also killed due to high temperature.

Trash removal and clean cultivation

The left over of crop or plant debris contain disease organisms and insects. Similarly weeds and other plants harbour diseases and insects of main crops. If the trashes of crop are not removed the harmful organisms and insects shall multiply and damage the next crop sown in that field. By burning trashes such a possibility is avoided. Weeds and other off type plants harbour pests during off season. If such weeds and off type plants are removed the possibility of pest attack is finished.

Sound devices

Producing sound expells insects like locust. Insects come out of their hiding places or sometimes fly away by sound. When they fly birds catch these insects which otherwise keep hiding. Sound devices can be obtained and used from places which have been utilising this devise successfully.

Colour bands

Insects of fruit trees are repelled by some colour bands of rings with coltar etc. This saves trees from infestation of such pests, which otherwise are very difficult to control e.g. guava grub, zizipus caterpiller etc.

Use of mechanical killer

Instruments or devices can be used for killing insects like beetles or flies which are otherwise difficult to be controlled. Hair cater pillers and larvae are easily caught by such devises.

Shaking of plants

Insects like white grub (Athelia spp.) are dropped on the ground by shaking of trees. Devices can be prepared for such pests in other plants as well.

13.2 Precautions

— Keep close watch on pests.
— Make a point to:
— Fix the mechanical device at such a place where pests cannot hide. Do not forget to take necessary steps if a pest comes to notice.

13.3 Materials required (For the light trap)

— Electric wire and bulb or petromax
— Light trap
— Plastic tub with water plus kerosene in it or a wire cage
— Polythene sheet added with resine paste or any crude oil sticker.
— Metallic tray of 50 × 20 cm size.
— Forceps—2 pairs

13.4 Procedure

— Put a pole in the centre of field near the electric post.
— Put on a high platform an electric bulb or a petromax.
— Below the bulb keep iron cage or a tub with water plus kerosene in it.
— Put this tub on a plastic sheet pasted with sticker.
— Put on the bulb or petromex.
— In the early morning go and examine insects and record the
— count. If some new pest probable for the crop is seen it should be noted.
— Bury the insects in the ground.

13.5 Questions

1. Why is it necessary to fix the light trap at a high point?
2. If a pest is caught with light trap, what does this indicate?
3. What happens when plant debris is burnt after the crop is harvested?

14. Activity Unit

POST HARVEST TREATMENT OF FARM PRODUCE (GRAINS, TUBERS)

14.1 Relevant information

Why the post harvest treatment is needed?

Grains and tubers as soon as they are harvested have got to be processed in such way that they become free from any foreign material. Grains and tubers may also carry insects and diseases from the parent crop and excess of moisture. These may help in deteriorating the quality of seed and help harmful diseases and insects to harbour there.

Steps of post harvest treatment

(i) Drying and washing

Grains need drying as soon as they are brought from the threshing floor. Potato tubers just after harvest need washing. Grains can be dried in the the following way:

a. *Sun drying:* Grains can be spread in thin layers on cemented floors open in sunlight during suny days.

b. *By mechanical drier:* Machines can be used for drying the seeds when sunlight is not enough or during cold/rainy days.

c. *Vaccum drying:* Special type of machines can be used for drying the seeds having excessive moisture.

This type of drying makes the drying quicker.

(ii) **Cleaning**

Seed material needs cleaning from plant debris, broken seeds, weed seeds etc. Plant debris in particular is necessary to be removed because of diseases present in it.

Cleaning can be done in the following way:-

a) *Use of Strainers:* Strainers of various sizes help in separating the seeds from foreign material.

b) *Density cleaner:* Machines are used to separate rotten or damaged grains. They are usually lighter in weight. Grains of uniform density are separated by such machines.

(iii) **Grading**

Bold and uniform size grains are usually good as seed material. Smaller seeds are usually ill-shaped due to disease or insect damage. These may act as source of disease or insect-pests. Mechanical grader machines can be used

for obtaining seeds of required grades.

Dehydration

Specialised treatment for removing moisture without subjecting grains to temperature is useful for getting good quality seed. It is quick and efficient method of getting seed without the risk of damage due to heat etc. This operation is done in specific machines by trained persons.

Moisture measurement

Measurement of moisture in seed is necessary for increasing storage life of seed. Excess moisture promotes disease and insect damage during storage while lower moisture content reduces germination and general viability of seeds. A chart of moisture limits in particular seed is available with certifying agencies.

Germination count

Count of germinating seeds is essential before and during storage of seeds. Standards of germination percentage are available to make the seed fit for further transaction. Seed germinators or other such machines can be used for exact measurement of germination counts.

Chemical treatment for decreasing or increasing dormancy in grains

Dormancy of seed is a limiting factor for grain seed industry. Dormancy helps in maintaning the germination standards in seed. Information can be obtained for this purpose from the agencies dealing with seeds.

Protection of seed from insect and diseases

Grains for seed may be stored after treating them with fungicides and insecticides. In such cases grains for seed purpose are unfit for consumption.

Cold storage

Potato, ginger, colocasia, turmeric, onion and other bulbs/suckers etc. are affected adversely by high temperatures when they are harvested. Their germination takes place soon and thus, their quality is lost. If such produce is stored at lower temperatures of 4-15°C their quality is maintained for 1-2 years. Big size insulated rooms are meant for this purpose where the temperature adjustment is done with the help of centralised cooling devices. Larger cold houses or rooms are more economical.

Prestorage treatment

Due to low temperature and humidity some organisms or insects are usually carried from field alongwith seed tubers to the cold storage. Such organisms are also harboured in cold storage for long time if they are not killed before storage. Therefore produce is first treated with fungicides, insecticides etc. There are recommended practices for such treatments also.

14.2 Precautions

— Do not store seed before giving required treatment, cleaning,

grading and drying.
— Do not forget to dry the produce properly.
— Keep close watch on diseases and insects carried with the produce after harve
— Select out seeds from

— Place a piece of blotting paper in a glass plate.
— Moist it with water.
— Place 20 seeds over moist blotting paper and cover the lid of plate.
— t germinated ed seeds.

14.3 Materials requ titute of Ed

— Sample of produce (about 2 kg.)
— Metal or polythene sheet 2m × 1m
— Grain strainer—small type or
— Grain separator or divider
— Weighing balance
— Glass dish
— Plastic bucket

14.4 Procedure (for sun drying)

— Weigh 1 kg maize seed.
— Spread it on the metal sheet.
— Keep it in sunlight
— After 3 hours, again weigh grains and note the reduction in weight. Repeat it twice.
— Separate big, small damaged grains and plant debris.
— Weigh each component individually and calculate the moisture content by substracting the two weights.
— Collect the dried grain in a seed bin.

Test germination as below:

— Observe the grain lot before and after grading.
— Observe plant debris and damaged or broken seed separated from the main lot.
— Observe the germination of bold seeds and damaged seeds.

14.6 Questions

1. Can we store the produce as such after harvesting?
2. What happens when uncleaned and ungraded produce is stored?
3. Why bold and good quality seeds are good for storage?
4. What step is more important for the produce after harvesting?
5. Why vacuum drying is quicker than sun drying?
6. Is germination count affected if the seeds are sun dried for a much longer period? If yes, why?
7. Is grading necessary for storage of farm produce? If yes, explain why?